VOL III NO 3

GENERAL LIBRARY
SEP 16 1918
UNIV. OF MICH.
Engineering Library

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

SEPTEMBER 1918

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

"We highly recommend Non-Gran Bronze, which we have used continuously for the past nine years—now used in over one hundred thousand of our motorcycles without a single complaint."

THIS is the text of the telegram that was flashed across the wires in response to an inquiry from a Federal bureau, asking for information regarding NON-GRAN in actual service.

HIGH SPEED
NON-GRAN
BEARING BRONZE

AMERICAN BRONZE CORPORATION

Berwyn Pennsylvania

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. III September, 1918 No. 3

The HEADQUARTERS SERVICE OF THE SOCIETY

WHEN an S. A. E. member writes, telegraphs, telephones or pays a call to the headquarters of the Society in New York, he is usually thinking of just one thing—service. The Society, in its very nature, is a service organization, its headquarters being naturally arranged with just that one end in view. Headquarters therefore provides the machinery for carrying on the thousand and one air-land-water engineering activities that are now part of the Society work.

The offices are in the Engineering Societies Building, 29 W. 39th St., New York City. This is now the home of 17 engineering organizations, to which belong a total of 56,000 members. The main building, thirteen stories high, was erected in 1907, through the generosity of Mr. Andrew Carnegie, who gave $1,500,000 for the structure, while the mechanical, electrical, and mining engineering societies were joint purchasers of the land. Last year a three-story tower was added, and the civil engineering society, which was formerly in a building of its own on West 57th St., New York, moved into the building. These four societies, known as founder societies because of their property interest in the building, each occupy a separate floor. Other floors are divided among a large number of American engineering societies. The building contains one large auditorium for meetings, this seating about 1000, and also has several small lecture rooms with capacities ranging from 100 to 500 persons. The Engineering Societies Library, which contains about 125,000 volumes and receives over 1000 periodicals regularly, is on the twelfth and thirteenth floors. This library is open to all for reference work, and special arrangements can be made for having research work done for those unable to visit it.

Early in the summer the S. A. E. offices were rearranged; the publication and standards offices, which were formerly on the seventh floor, were moved down into new space that had been taken on the sixth floor, until at present the Society occupies practically the entire office space on the sixth floor of the building. A lecture room on the same floor is being used by the Gage Branch of the National Bureau of Standards; this is a particularly appropriate neighbor in view of the immense amount of standardization work performed by the Society.

Before explaining the work done at headquarters, it may be well to outline the general organization. The affairs of the Society are managed by the Council, consisting of fifteen members elected by the members of the Society, and acting as a board of directors. Reporting to the Council are a number of working committees made up of Society members. There are now five administrative committees, as follows: Finance, Meetings, Membership, Publication and House, with duties indicated by their names. Then there are the eight sections of the Society located at different automotive engineering centers with their own local organizations. The Standards Committee of the Society with its twenty-three divisions consisting of nearly two hundred members, is also under the supervision of the Council, which designates members for service on the committee and approves any new subjects before they are officially considered by the different divisions. Committees are appointed by the Council from time to time to handle special problems that may arise.

All these different activities of the Council and the other committees are carried out by the executive staff of the Society. This consists first of a General Manager and Secretary, and under him of a number of assistants who look after particular phases of the work. These are the Standards Manager, in charge of standardization work; Field Secretary, who looks after membership, section and publication activities; an Assistant Secretary now stationed in Washington in charge of the S. A. E. office there; and an Office Manager, who is responsible for the detail work carried on at headquarters. The duties of these officers can perhaps be considered best in connection with the accompanying layout of the present Society offices.

In general it may be said that the House Committee of the Society, which approved the present office layout, had three considerations in mind: (1) The efficient operation of the office; (2) the convenience to the members of the Society and other visitors to the office; and (3) the space available, which necessarily determined the final arrangement to a considerable extent.

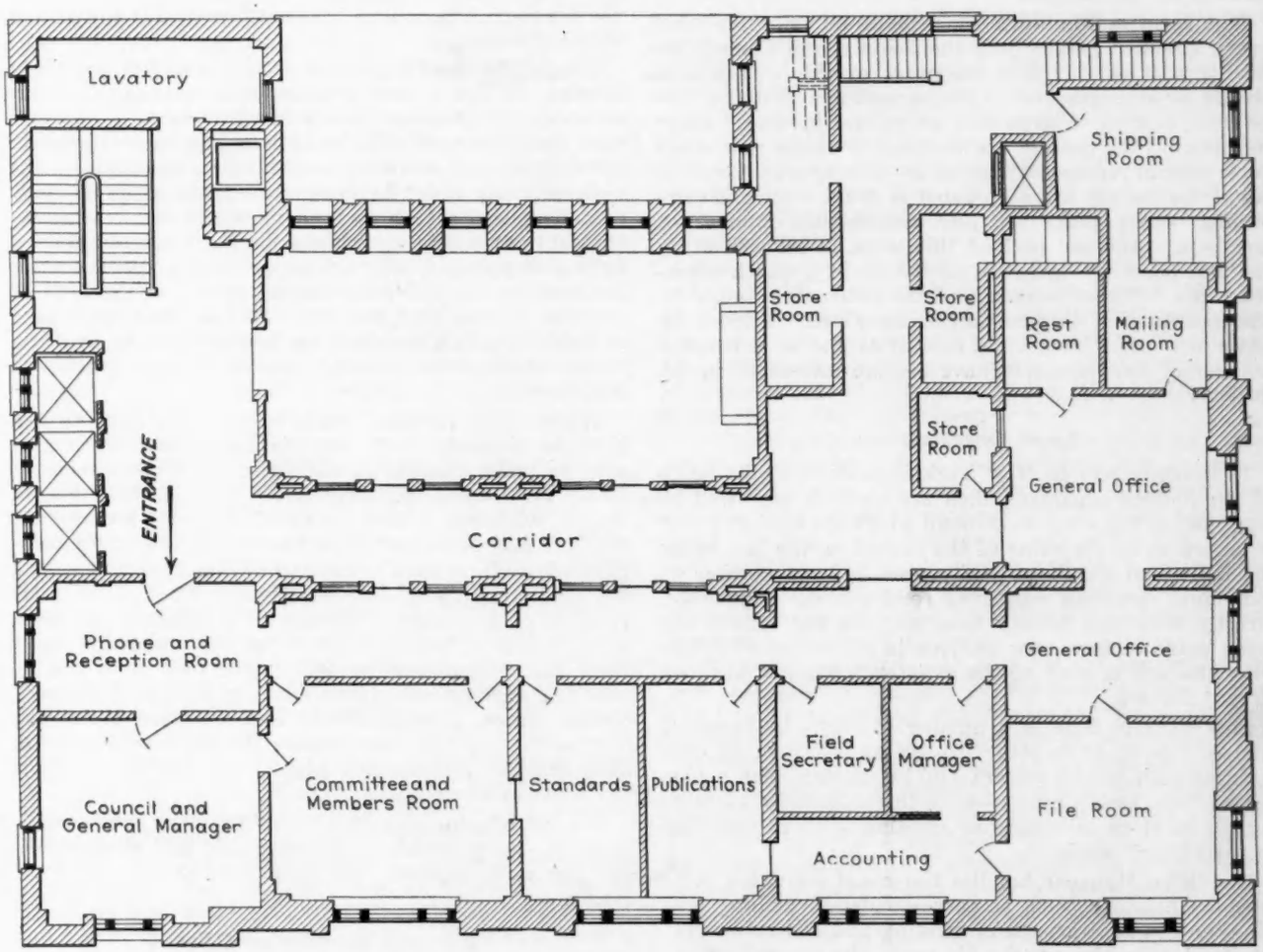
From this layout it will be seen that the main entrance is through the first door on the right, as the S. A. E. member steps off the elevator. This door leads into a small reception room, where a telephone operator is placed to give information and receive visitors. Directly beyond this room is the Council Room, which is also used as the office of the Secretary and General Manager. A large room immediately beyond is available for conferences when needed and at other times is used by the members. This contains a conference table, writing desks, a number of exhibits showing the standardization work of the Society, and racks on which are kept the technical papers.

Next in line is the office used by the Standards Man-

ENGINEERING SOCIETIES BUILDING, 29 WEST 39TH STREET
(Photograph marked to indicate location of S. A. E. Floor)

ager and assistants. The standardization work of the Society is growing in volume all the time; it consists of the preparation of subjects which are to be considered at meetings of the Standards Committee and its divisions, and the preparation of minutes of meetings, of reports on standardization, and of data sheets on standard practices. A considerable part of the standards work consists of correspondence and conferences with members of the Society or others in the industry who desire information regarding the standards already in force. Reprints of the data sheets are available for sending out to non-members under certain conditions, but the special information desired often requires considerable research work. An important function of the office is to bring to the attention of manufacturers and others the value of the standards and in cooperating with them in working out new subjects suitable for standardization. The office serves as a medium for creating a willingness and desire among industries to work for the greatest good of all. The whole work actually results in saving dollars and cents to manufacturers, purchasers and users. The standards department also prepares and conducts exhibits of a general educational nature at important national exhibitions.

The publication office does all the work of preparing the monthly issues of THE JOURNAL and the two volumes of the TRANSACTIONS issued each year. The papers and discussions presented at the Society and Section meetings, the speeches made at the Society dinners, the records of current standards work, all of these and much general matter of interest to Society members are prepared for publication and sent to the members of the Society. In this office also the technical advertising carried in THE JOURNAL is handled.



FLOOR PLAN OF S. A. E. HEADQUARTERS ON SIXTH FLOOR, ENGINEERING SOCIETIES BUILDING

In many cases the authors of papers printed in THE JOURNAL desire to have them printed in separate pamphlet form. Such reprinting is handled by the publication office, subject to certain restrictions as to form and style laid down by the Council of the Society.

In the publication office is carried on all the personnel work, the result of which appears in the section known as "Men and Positions Available" in each issue of THE JOURNAL. While the work consists primarily of the insertion of such notices, there is a great deal of other detail connected with it, such as actual conferences with members looking for positions and with others looking for men. A system has been evolved for handling the work by mail. A member looking for a position fills out a form, and copies of this form are sent to employers interested. The members of the Society are entitled to the insertion of a "Men Available" notice in THE JOURNAL three months of any one year. The use of the "Positions Available" section is open to any reputable employer, but

particular pains are taken to see that the notices are up to date and are not carried after the positions have been filled.

As stated previously, the direct supervision of the publication work falls to the Field Secretary, who is responsible also for the membership and section activities of the Society. The last two are carried on under the general charge of the Membership and Sections Committees of the Society.

The membership work consists of an effort to have every qualified person join the Society, the Council believing that at this time the work of the organization should be strengthened to the utmost and that this can be done best by a large and active membership. Many members in the Society are working to secure new members; special representatives of the Membership Committee of the Society are designated in every state and community where there are any considerable number of members. Another part of this work is carried on by the Membership Committee of the Society, which represents the different branches of the automotive industry. The members of this committee have been in touch by letter with their respective industries and as a result a number of new members have become interested in the Society.

Local Organizations

If headquarters in New York is considered the heart of the Society organism, then the sections may well be imagined as the arteries through which the Society spirit is passed on to the veins of the organism, the last being the individual members. Of course, a large number of individual members must yet receive their inspiration directly from the Society headquarters, but efforts are being made to form new sections in a number of different cities and to give all the assistance possible to those already formed.

This work is done in a number of ways, by personal visits of the Field Secretary to section meetings, by conferences with section officers, and by correspondence conducted from headquarters—all with the purpose of helping the sections in arranging meetings and in carrying on their detail work.

The Office Manager handles the usual activities indicated by his title, such as correspondence, mailing and filing, and in addition the accounting and other financial details. Under him are the file room, the general offices, where most of the correspondence is handled by dictaphone operators, the mailing and shipping rooms.

The file room includes cabinets for ordinary correspondence, these being arranged according to a combination of the alphabet and numeric system, known as the "automatic." The correspondence and other papers relating to standards work are of a highly specialized nature, however, so that for these the subject system of filing is used.

It also contains an extensive system of files for the storage of the cuts used in the Society publications, and separate files for the applications of members in good standing, and for applications in process.

Each membership application that comes in is checked to ascertain whether the applicant has in any way been connected previously with the Society; whether the information required by the Council is given; and whether the references given are to members of the Society. If there is any information lacking a special letter is sent to the applicant; otherwise a summary of the experience of the applicant is prepared and sent out to each reference, who is asked to supply this information in order to help the Council to determine whether the applicant should be elected a member of the Society and in what grade. At this time a note is prepared for THE JOURNAL, as required by the Constitution of the Society. The name of each applicant must be published once before any action can be taken on the application by the Council. After this detail work is done the application is sent to the file room, where it is held until ready for submission to the Council.

One of the most important activities of the Society is keeping up the record of member connections and addresses. At present this is handled in four separate card files, arranged alphabetically according to the member's name, alphabetically according to the name of the company with which he is connected, and geographically according to location of both members and companies. In addition to this a separate file has been maintained arranged alphabetically according to the article manufactured by the different companies and to the kind of position held by each member. Still another file is kept of fields in which members are interested, such as Aeronautic, Automobile, Tractor, Marine, Motor Truck and Motorcycle.

Whenever a member sends in a notice that he has changed his address or company connection, it is necessary to make changes in one or more of these member files. This has to be carried on in wholesale fashion, of course, whenever a new roster of members is compiled. While it may seem that these files are unnecessarily complicated, all have been found essential in carrying on the Society work quickly and effectively. When a notice is received of a change of address to a different city with a new company and a different line of automotive business, six changes are needed in the card files and at least two changes, sometimes more, in the file of addressograph plates. From 8000 to 9000 of these plates are filed in the mailing room, where the machine for using them and for making new plates, and the mimeograph machine are also placed.

The list of addressograph plates is rather complicated in itself, being arranged alphabetically and geographically for each member, and then further separated by grades.

Work of Washington Office

One unique feature of the Society has not been mentioned in this outline of its activities. It is doing a very important work, work dependent, however, on the war, in the Washington office, where an assistant secretary with the necessary clerical aid is stationed. Perhaps the most important work done in the Washington office is the cooperation with the Government, in suggesting names of members of the Society who are qualified to fill engineering vacancies, either in military or civilian service. About a year ago a census was taken of all the members of the Society and all new members since that time have been requested to fill out the same blank. These blanks are filed and properly indexed in Washington so that the information is always available for helping the Government.

In addition to the personnel activities, the location of an office in Washington affords the Society an opportunity to keep in close touch with all the technical activities being carried on by the Government and to render quick service when needed.

Speeches at Salina Dinner

OVER three hundred members and guests of the Society were in attendance at the Tractor Dinner held July 31 at the Hotel Lamer, Salina, Kansas. The occasion of the dinner of course was the National Tractor Demonstration, which was held just outside Salina during the week from July 29 to Aug. 3.

A long list of speakers combined to furnish inspiration and entertainment for those at the dinner. Judge C. W. Burch of Salina acted as toastmaster; he spoke of the immense amount of farming work being done in Kansas and welcomed all present to the Demonstration. He also emphasized the importance of the work the Society is doing in standardizing details of tractors. The other speakers were Arnold P. Yerkes, assistant agriculturist for the Department of Agriculture, who described the work his department has been doing the past year; Prof. J. B. Davidson, head of the department of agricultural engineering of the University of California, who described some of the work which is being done by tractors in California; J. B. Bartholomew, president of the Avery Company, who told about a recent trip to California; J. H. Everson, sales manager, International Harvester Company, who explained the work that his company is doing in educating tractor operators in special schools in different parts of the country; Finley P. Mount, president of the Advance-Rumley Company, who spoke on the need for cooperation between the scientists and practical men; and E. J. Gittins, vice-president, the J. I. Case Threshing Machine Company and chairman of the committee in charge of the National Tractor Demonstration, who stated that the show being held this year was the most satisfactory and educational that has ever taken place. The remarks of the various speakers are given below, together with those prepared by C. M. Eason, manager of the tractor department of the Hyatt Roller Bearing Company, who had been called to Washington on Government work, and Lon R. Smith, sales manager of the Buda Company, who did not deliver his address at the dinner because of the lateness of the hour.

JUDGE BURCH:—This occasion is attended with pride upon our part, and yet with seriousness. We appreciate that there is assembled tonight the scientific acumen of this great Nation of ours—skilled engineers, educators, captains of industry, men of large affairs, manufacturers, distributors, salesmen, every one essential in his place.

Time was when competition meant the vicious attack, the tearing down, the destruction of the competitor, but here it seems that competition means helpful association, constructive upbuilding, each man with a "boost" and with an effort only to try and do something for the other fellow. We are certainly happy to join in this wholesouled comradeship and yet, withal, we are impressed with the seriousness of the occasion at this present time.

The greatest events of the world's history are taking place. The hungry and the oppressed of Serbia and Roumania, the noble people of England, the martyrs of Belgium, the courageous and heroic French, all are looking to us to develop and conserve and muster our resources. The supreme test of our brain power is to increase our production and yet conserve our manpower. It requires patriotic devotion to duty on the part of every citizen. The work of the S. A. E. was never so important as it is today.

Living here in Kansas I feel that the tractor is the most important implement for the development of our agricultural resources. And yet I am told with the advent of the tractor came the problems of the Society. It meant a change of power appliances to tools and machines; the reconstruction of tools and machines to the speed of tractors; and that old forms had to be relegated to the scrap pile.

Efficiency is the watchword of the hour; efficiency in a large sense means coordination of our powers, mental and physical. It results in the elimination of waste of time and material. Standardization of parts, of machines, of materials, of equipment and of tools is of supreme importance now. It will not destroy individuality, it will not discourage, but it will rather inspire inventive genius.

In the Kansas language, now is no time to pull off any individual bonehead grandstand plays. What we want is teamwork, cooperation of all our powers and our resources, and we will win. It is the time for us to think great things and achieve great things. We must stand behind our army at the front and we must stand behind the Government.

Governor Capper was in town this morning and asked me to express his regret that he could not be present here and to make his speech for him. Speaking about Kansas, the Governor would say that 25 years ago if the word "Kansas" was mentioned any place else in the United States everybody winked and had a grin on his face. They talked about grasshoppers and droughts and hard times and cyclones and populace and politicians; but that is not heard any more.

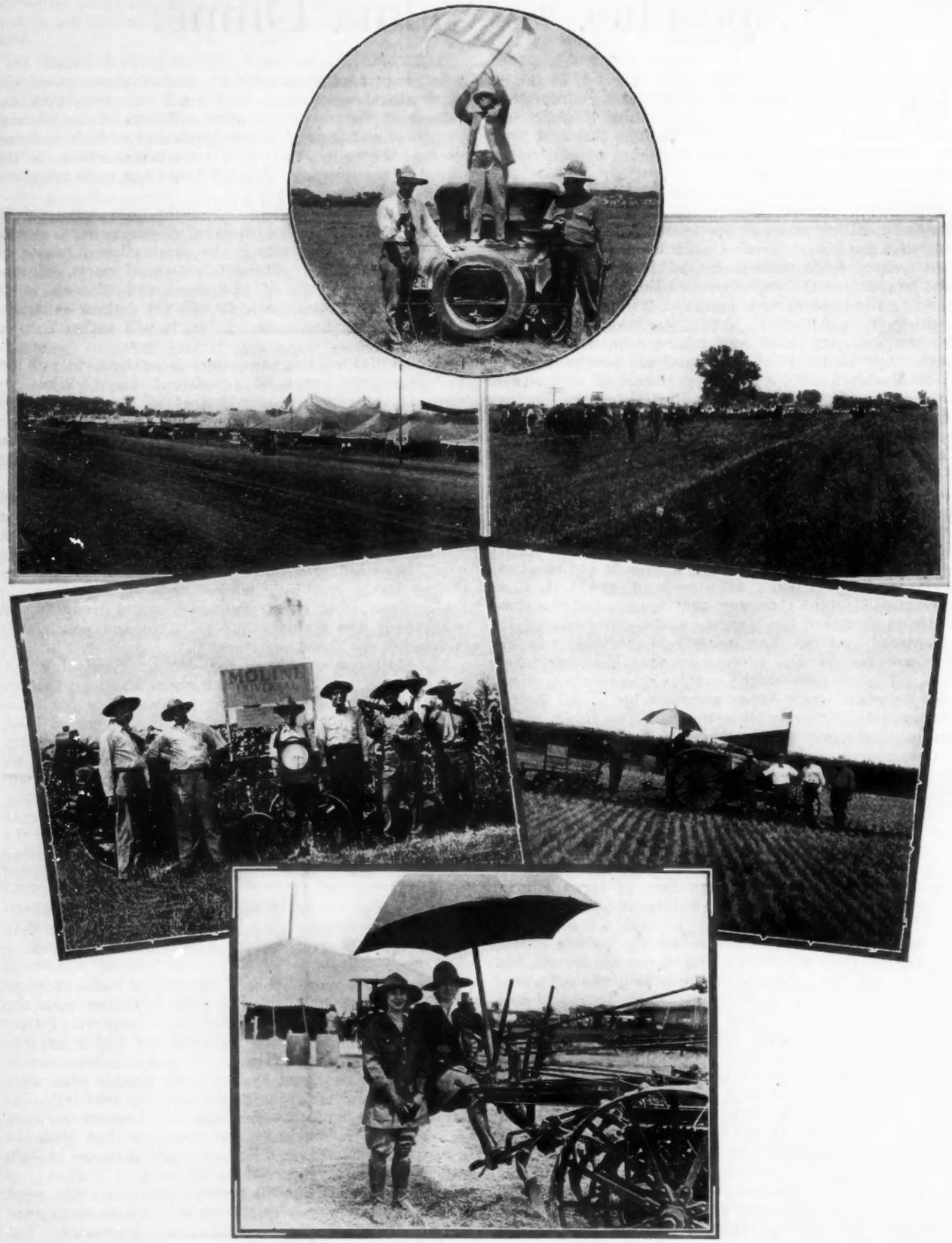
The Governor would say that we are furnishing ore, lead and zinc, and coal and gas for manufacture; that we are furnishing oil and gasoline in abundance for automotive machines. We have cattle on a thousand hills, we have herds of swine and sheep, we have poultry products and dairy products, we have alfalfa hay, we have provender; and we have forests of corn that will feed and fatten all this stock for the world's market, and that in addition will give all the corn bread we want to eat for a year. Every ninth biscuit eaten during the next year will come from Kansas, because we are raising 100 of the 900 million bushels of wheat of the United States this year.

MR. YERKES:—I think the Department of Agriculture has done three times more work in this last year than in any three years before, and that means much work done.

As soon as the war opened, the office of Farm Management started to help out the labor situation with the farmers cooperating with the Department of Labor. We have organized every state in the Union to help furnish labor for the farmer. Practically everyone in the office was assigned to the work, outside men were brought in, and an organization built up that last year did wonderful work, but this year has done much better because labor is much scarcer this year than last. In spite of this, we haven't had as much shortage in help this year as last year.

In Kansas alone 40,000 people from the cities went out this year to help with the crops on farms and staved there until practically everything was harvested. Not nearly so much wheat is standing in the fields this year as there was in years before the war.

Another thing that we are gratified to hear from the



SALINA TRACTOR DEMONSTRATION: AT TOP—GOVERNOR CAPPER OF KANSAS STARTING PLOWING ON FIRST DAY. VIEW OF EXHIBITORS' TENTS. MACHINES LINED UP FOR PLOWING. APPARATUS USED IN DYNAMOMETER TESTS. TRACTOR THAT MADE 103-HR. RUN. WOMEN TRACTOR OPERATORS

implement people is that the sale of larger machines is increasing. The Office of Farm Management has issued bulletins urging the farmer to use bigger machines. These were especially directed to the South, but have covered the whole country. A comparison was made between the old one-mule plow down South, the two-horse walking plow, the three-horse sulky plow, the three or four horses on the gang plow and then the tractor. The agents and men doing service work tell us that these bulletins have had a wonderful influence in increasing the use of larger tractors.

One dealer down South said that in the last 15 years he had sold only five riding cultivators, but this year he has sold 122. This shows results. We did not do it all—a farmer has a lot of gray matter and he knows that when he gets short of help he must use implements—but we know we have had some influence.

I think the implement people have got along much better than many other industries. They have been getting materials slowly (they come to them from hand to mouth), they have had trouble with their labor supply, and coal has been hard to get. The greatest trouble we have had this year is in getting transportation for implements. The Director-General of Railroads will do anything he can so long as it does not interfere with transportation of war materials or soldiers, but as long as there is one soldier or one gun to be moved we have to stand back.

I want to say, too, that the manufacturers have certainly been "true blue." Time after time manufacturers have said, "We've got hundreds of carloads of stuff to be shipped," or else "We need more material," but when we explain the situation, and tell them the reason, they have said, hundreds of times, with loss staring them in the face, "Go to it. We're not going to do anything that will interfere with the war."

PROFESSOR DAVIDSON:—I am proud I am a professional educator, because I believe that education is to be a large factor in the progress of the tractor. The economic success of a tractor is a triangular contract. In the first place, the work. Sometimes tractors are used for work for which they are not adapted. I used to think they could not be used on hills. I went to Pullman and have changed my mind, because the tractors there negotiated the 55 per cent grades successfully.

The success of a tractor is a triangular affair. In the first place, the work; in the second place, the tractor. There are good and there are bad tractors. The third factor is the personal factor, and it has been my observation that it is the most important of all.

A capable man will make a success with a mediocre tractor. Put the best tractor built in the hands of a man who will not care for it, or who does not know how to care for it, and it will not be a success. The thing that will make the capable operator is education.

California is a place where the tractor man, the tractor engineer, ought to go. The principal thing about our great state is its variations and extremes. We have the dryest locality in the United States and the locality which has the highest rainfall; the highest altitudes and sea level. We have some of the coldest and some of the hottest country. We have some of the hardest ground and some of the softest ground. We have conditions that will try a tractor to its utmost, and if it is desired to test a tractor under variable conditions, California offers more than any other state in the Union.

In no place in the world is the tractor so thoroughly recognized in agriculture as in California. We have motorized farming; we have many farms that do not have a single work animal upon them. We have used tractors for a long time. The tractor is no longer a debated question in the state.

We have the most discriminating buyers anywhere to be found in the United States. A quality tractor will find a better reception in the state of California than in any other state in the Union. The California rancher is willing to pay a higher price for a tractor than a rancher or farmer anywhere in the world.

We have been determining drawbar pulls and drawbar horsepower here at the demonstration. I think that a standard method of rating would be a good thing; would be only fair to the purchaser. The drawbar horsepower rating of a tractor ought not be the paramount matter in a sale. No salesman would suggest that price ought to be the paramount issue in selling a tractor. A salesman who has nothing to talk about but price has nothing to say, and the man who has nothing to talk about but horsepower has very little more to say. I am satisfied that the time is coming when we will have some method for the standard rating of tractors.

The tractor industry got along very well with few engineers for a good while. It seems that of late the professional engineer has been flirting with the tractor industry and since some tractors have not been so thoroughly "engineered" there is just a little resentment. The tractor industry needs professional engineers. Many things that could be handled on a strictly scientific or engineering basis would be much to the advantage of the tractor industry. A tractor is having trouble with the heating; with the cooling system. Is that a serious problem? It is possible to take any engine and determine how much radiation it needs. It is possible to take any radiator and find out how much radiation it will provide. Need we worry about that and go along with cut-and-dried methods?

In my opinion many tractors on the market are not sufficiently well engineered. If history repeats itself, when we have a meeting of this sort in years to come there may be just as many engineers but there will not be as many tractors.

A great deal of money has been invested in the manufacture of tractors by people who should have secured the best talent to advise them concerning the manufacture of that tractor before they ever started. It is a strange thing that business men sometimes make a success in one line, and then go into another line and deprive themselves of the advice which would save them thousands of dollars.

The man who has been close to the soil, who has been designing because he appreciates the requirements to be met, can give many helpful suggestions. Most of our farm machines have been designed, not by professional designers, but by farmers themselves. The refinement has come from the professional designer and the manufacturer, but the fundamentals of the machine have come from the farmer.

MR. BARTHOLEMEW:—Now that the freaks in the tractor line have all been eliminated and the plows have all been reduced to one-man plows so that one man for each bottom and each lever is sufficient, I feel that we can commence to standardize. I would like to see every outfit that pretends to be a one-man outfit run by one man.

I came here from Kansas City, and as I looked out the car windows and saw the magnificent crops that were being harvested and the magnificent crop of corn

MACHINES AT WORK AT SALINA DEMONSTRATION: TOP—FORD AND CASE. SECOND ROW—BULLOCK AND CLEVELAND. THIRD ROW—BATES. BOTTOM—INTERNATIONAL AND AVERY

standing all along the way, with hundreds and hundreds of horse plows working, I felt that the manufacturer, who rarely comes to Kansas, should see them and also see in Kansas the opportunity for the tractor.

MR. EVERSON:—Professor Davidson, in his address, referred to the knowledge that the operator should have in working the tractor. The government department of which Mr. Yerkes is a representative endorses the education and training of the tractor operator, and the War Department of the Government has also, and is educating men along that line. Somebody has said that 50 per cent of the troubles of a tractor are due absolutely to lack of knowledge in the operator. I am not prepared to say whether that is the right percentage, but I do know that it is an important point.

State universities are doing good work in educating tractor operators. Many private schools, and a number of tractor manufacturers, are doing educational work, and I am going to outline what the Harvester Company has been doing in the past few years.

We feel that the colleges and private schools are not reaching the people fast enough, so we are doing some auxiliary work. First our branch houses all over the country were asked to select one of their men best fitted to impart information to the farmers in their communities. We held a tractor school, a teachers' training school, at one of our Chicago plants to train those instructors. Also, when they were instructed we suggested to our branch houses that wherever there were 25 or more farmers that could be reached in a rural community we would take the school to the farmer, to his home, where he could get the benefit of this instruction. Wherever it could be arranged we held a tractor school. Instruction was given by a system of charts, stereoptican slides and booklets.

We have held 599 such schools throughout the country, and we expect to hold some more next month. We had 46,000 men enrolled in them to get information about the tractor.

These schools were open, not only to tractor owners or prospective buyers of the Harvester machines, or the particular friends of the company, but to everybody. Of the number of attendants, 70 per cent were owners of International tractors; 30 per cent were owners of other tractors.

If other manufacturers have the product that will justify such educational effort, we would like to have their cooperation. It would be well if other companies that have not yet started this educational work gave some thought to it.

The farm paper publishers can help this work by encouraging farmers to take advantage of the tractor schools that are put on by the manufacturers, to read the instruction books and the literature we are sending them in trying to help the industry.

MR. MOUNT:—Sometimes I think the best thing that can happen to the tractor industry every year, the best thing that can happen to every manufacturer of tractors today, is for somebody to make a better tractor than any of us has. A better tractor (and we all claim we have the best one); a tractor better than any tractor any of us are making today is not going to hurt but help each tractor manufacturer in America. We should be of open mind; we should try to serve our own interests; we should be ready to take advantage of the fact that anything that is better than what we have had in the past will make the market bigger and more beneficial to every one of us.

I have due deference for what has been said here by the scientific gentleman, but it is not always science that wins and works out. One may chart according to scientific tables any problem in tractor manufacturing and find himself in need of common sense and practical experience.

Science worked a long time, and needlessly, too, in trying to determine a scientific method of standing an egg on end, but practice cracked the egg and stood it on end.

There is need in the industry for a big spirit of cooperation; cooperation on the part of the scientist; cooperation on the part of the manufacturer. I know by experience, and I have an idea it is the experience of every manufacturer who takes up a problem in tractors or any other kind of machinery construction—he puts it up to the S. A. E. members associated with him—asks them to figure it out; then he goes back to see if it is figured out right. And sometimes he finds that it "ain't so."

So there is room for practical experience. We cannot get away from the fact that the tractor industry is a new thing; that the problems put up to a tractor to do are problems which even as august a body as the Society of Automotive Engineers has not yet wholly solved, although we hope it will do so.

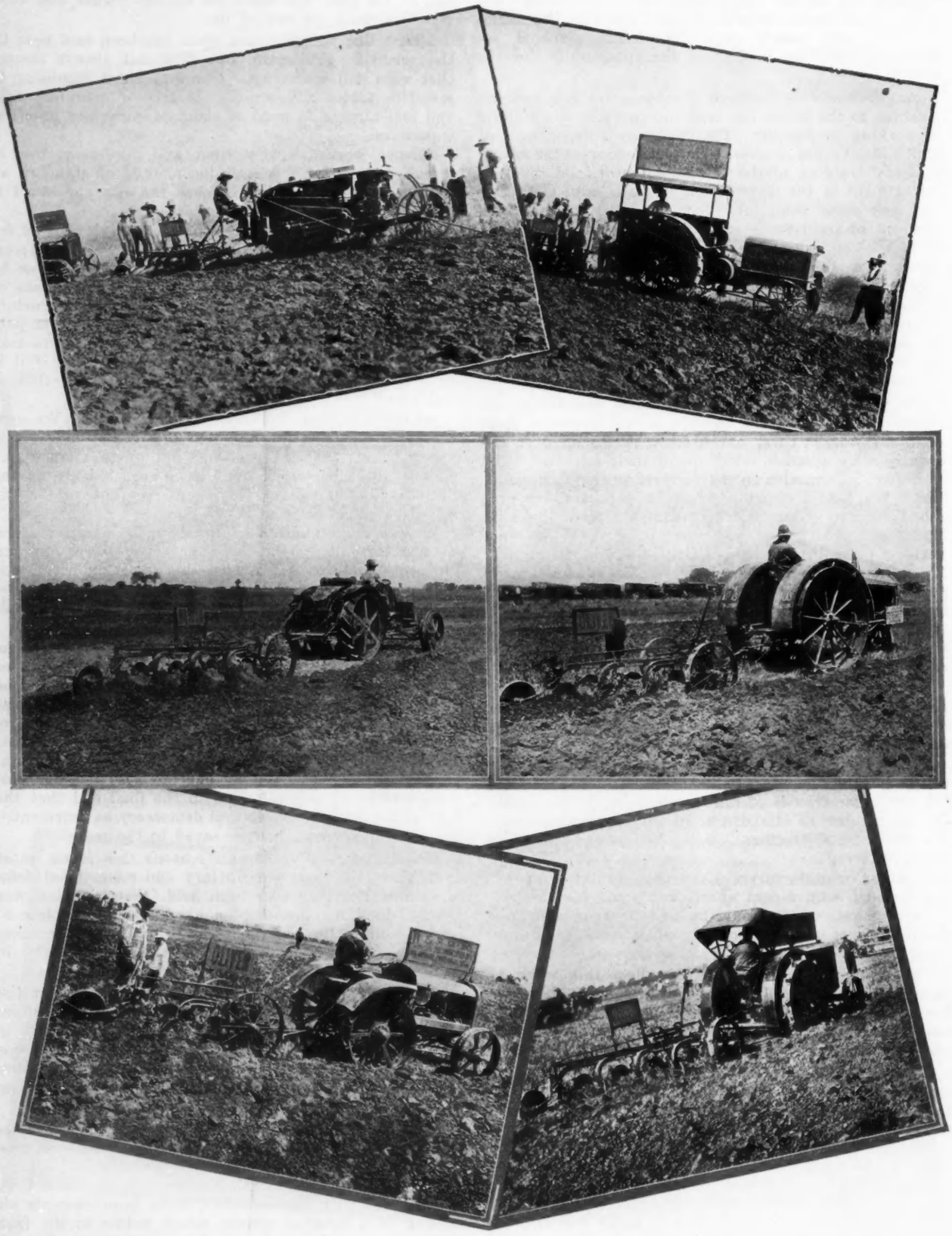
We are here tonight as engineers, as manufacturers, as members filling the various useful professions incident to and connected with this great industry, but first and foremost of all we have just one business—each and every one of us has one business and the sole business of each and every one of us is war.

In whatever position we occupy, whatever we do, whether it be in the designing of a newer and better tractor that will enable the greater production of food or whether it be in the production of more tractors that will enable a still further increase of the great production of wheat in Kansas, as well as other states; whatever it may be, we must work unceasingly and untiringly to conduct not only our business but our personal life in all our relations to the final end that the Hun shall be put back and that democracy as represented by our Government shall be saved to the world.

MR. GITTINS:—For several reasons this is the most gratifying, the most satisfactory and educational demonstration that has ever been held. First, Salina was selected by the committee unanimously as the place to hold the one national demonstration in 1918. The selection was made because the conditions were right in Kansas and in Salina.

All of us who have come from the East have seen the things that we have been praying for—crops—and we have seen crops galore. We came from Kansas City to Salina by daylight and saw the most magnificent crops that I have ever seen in Kansas, and I have seen many of them—wheat, oats, barley, corn, everything, threshing going on, busy everywhere.

The casual observer may not think that the development of tractors is progressing rapidly, but I can give assurance that it is. If one goes about and carefully examines the different makes of tractors, he will find, as compared with former years, many improvements all tending to a common center, which points to the fact that we are coming nearer and nearer to a single idea of the ideal, not exactly in outline and general appear-



TRACTORS PLOWING AT SALINA, JULY 29 TO AUG. 2, DURING TRACTOR SHOW: TOP—GRAY AND AULTMAN-TAYLOR. SECOND ROW—NILSON AND ATLAS. BOTTOM ROW—R. & P. AND LAUSON

SIDE GUIDE & GRIPPER

ance, but as regards what constitutes a successful, efficient tractor.

Now, first of all, in the tractor business, the tractor must be efficient. Nothing will succeed in any business unless the material or the product does the work. If our product is not successful, no matter what our sales organization or any other part of the organization may be, we can not progress. First of all we must see to our product, and if we have the product, it is up to our organization, methods and policy to succeed.

Parts Makers and the Tractor Industry

Mr. Smith:—We do not believe there is any question as to the position the parts maker occupies or as to his attitude toward the tractor trade. The parts maker is in identically the same position as he has been for years in the automobile industry. In that, parts makers are responsible for a great portion of the progress and success of the automobile.

1—The tractor is primarily a road locomotive the same as the passenger car and motor truck, only being more sturdily and massively built.

2—To build tractors complete in one plant requires an enormous expenditure of money and time, and a design must be developed to an extreme degree to warrant such an expenditure.

3—Experimenting in the building of engines, not to mention other necessary parts, can ruin the best financed companies.

4—The tractor is logically a machine that will be used in large numbers—hence it must be produced in quantities.

5—Tractors must likewise be sold at a price within the reach of the great majority of farmers who *must*, as we see it, adopt it. This can be accomplished only if we produce them in large quantities, thereby decreasing the cost of production and the selling price as well.

6—Parts makers who specialize on their lines of work, such as engines or transmissions, are, we believe, in a better position to handle their particular line than could possibly be the case if one company tried to solve all the problems.

7—When one manufacturer making tractors complete has the problem of working out the design of each individual part, his efforts cannot reach the desired point in the same length of time, or at as little expense as will result from the efforts of hundreds of parts makers. In one case it means individual effort; in the other it means concentration of the efforts of hundreds. Likewise the expense borne by the individual manufacturer in the one case is divided among hundreds in the other.

8—As stated before, the parts maker is a specialist. It is only reasonable to suppose, therefore, that he knows more about designing and building his own particular part than could any manufacturer who, owing to his great task, covering all the units in a machine, could not possibly devote as much time or attention to the single unit, particularly if he ever expects to be in the front ranks of the industry.

9—The parts maker takes just as much interest in the supplying of repair parts for his product—new or old—as does the tractor manufacturer, and possibly more than some of them, hence there is no argument on that score. It must be remembered that the parts maker *is not new* to the business. He has grown through years of earnest endeavor into a permanent position in the trade and will continue to grow with it.

10—The tractor owner's problems will be the problems of the parts maker also, and, because of this, progress is bound to be made—and made more quickly—than if their solution is left to the individual effort of any one or two manufacturers of complete tractors. What has been proved in the past twenty years in the automobile industry is sufficient guarantee of the future to the tractor manufacturer.

11—The production of the tractors in quantities will undoubtedly fall to the lot of the assembler. In other words, the largest number of makers of tractors will assemble them. Their production, considering investment, will be far greater than is possible in any other way. There will be large producers who will make practically complete machines, but these will be the exception rather than the rule.

Tractors from the Farmer's Viewpoint

Mr. Eason:—Just at present the farm tractor is the one subject uppermost in the minds of practically all automotive engineers. Whenever two or more are together, the chief topic of conversation is gear ratios, drive wheels, plow drafts, etc. It is quite fitting that this should be so, for the reason that on the farm tractor depends the future food supply of the world. The manpower resources of this country in particular have been seriously interfered with by the great conflict in Europe. The war has withdrawn a big percentage of men from our farms. In past years less than 10 per cent of our population have furnished food for themselves and the other 90 per cent. Even at that, we have had a surplus for our neighbors across the seas. At the present time, even this 10 per cent has been reduced by withdrawal from farm work of men, not only for army service but for service in our munitions and supply factories.

It is absolutely imperative therefore that the production per man on the farm be materially increased, otherwise we shall have to "Hooverize" a great deal more than we have in the past. Our present farm power resources consist broadly of twenty-five million horses and mules, and of perhaps slightly less than ten million men. While it is possible to increase our food production by using the immediately available power resources, it means bitter hard work to do it, so that the tractor offers the only practical solution to the problem of increasing production to our former standard.

Under these unusual conditions, it is not surprising that the tractor industry in the past two years has grown by leaps and bounds, production doubling every few months, with the demand outrunning the production two to one. Possibly we may be excused for feeling that the tractor has arrived and that we are now all set for clear sailing, with no trouble in the future except the problem of securing enough raw material to build the tractor.

Would it not be expedient at this time to stop, look and listen, to make sure whether this tremendous impetus in the tractor industry is due entirely to the fact that we have absolutely solved the problem of farming with power, or to some other causes. No one can deny the fact that mechanically the tractor has been improved more in the past year than in any five years previous. This is also true of many other devices forced upon us by the great war. Airplane production in this country has increased hundreds of times in a few short months, but I do not believe that anyone connected with the airplane industry believes that we have made the final airplane, and I do not believe that anyone in the tractor industry feels that we have yet made the final tractor.

The question may rightfully be asked—why worry

SYDE GUIDE & GRIPPER

about the ultimate, when it is of such pressing importance that we make tractors the best we know how right now in order to meet this emergency. Unquestionably, making any sort is our problem today, but after the present emergency is met the question is not going to be, How many? but rather, What kind?

After all is said and done, the purchasing public ultimately determines the design of anything offered in the open market for sale. I often think that we, who are connected with the designing of tractors or automobiles, take ourselves much too seriously in the weight we give our own personal ideas and opinions; after all, it makes no difference what any of us thinks individually or collectively. It is what the farmer, himself, after he buys the tractor and uses it for a year or two, thinks of the proposition that determines whether the design of a machine is right or wrong.

It was my good fortune to have been born on a farm in southwest Kansas. Fifteen years ago or a little more, we had in our county of nearly one thousand square miles, thirty-five or forty steam plowing rigs; these were turning over the ground for wheat, taking the place of horses to a considerable extent for this work. I have hauled water many days at a stretch for a steam plowing outfit. I have also shoveled coal, cleaned the flues and polished up the brassware. Sometimes when the engineer wanted to take a nap in the shade of the cook wagon, I would drive the rig for an hour or two. That was about as long as I could stand up to the job, because it was work requiring the strength and endurance of a regular man-sized man. Steam plowing rigs are not much in fashion out in that country now, the fundamental reason being that they are too hard to run. It takes too much attention, too many men and too much fussing to turn over a quarter section of land with a steam rig.

The large part of our tractors today however consists of smaller machines—the demand being principally for a machine that can be operated by one man. I believe the gist of the whole matter is "one-man operation." I also believe that the tractor of the future will be only as large as one man can conveniently and easily operate. These tractors will probably be larger than two or three-plow in size. The ultimate development is toward increasing the man efficiency, and this will, very likely, result in the making of larger units, but whatever the size, they will be strictly one-man tractors. It is not so much, however, a matter of how many bottoms the tractor pulls, as how much work one man can get done in one day with one tractor.

Besides being capable of one-man control, this control must be easy. The tractor of the future will be a tractor that a man can drive from sun-up to sun-down and then still be able to take a ride with his family in a car or go to a dance. It will be easier to operate or steer than the average automobile of today; it *must be* easier, otherwise a man will be thoroughly worn out at the end of the day's work. One of the reasons for trouble with tractors today is that the man who drives is so thoroughly tired that he doesn't care what happens to the tractor. He will run it as long as possible because he is too tired to fix it, even if he knows it doesn't act just right. Consequently, he drives ahead until something actually goes to pieces; then he blames the tractor, when it really isn't the tractor's fault, but the fault of the tractor engineer, who made it so hard for him to run the thing that he is too tired to take care of it.

Another detail that requires the earnest attention of tractor designers is the application of tractors to farm work. Reduced to the simplest terms, a tractor is a piece of apparatus for converting liquid hydrocarbon fuel into food stuff. Any consideration of the tractor solely as a piece of mechanism, without due consideration to the implements with which it must be used in order to accomplish its fundamental purpose, is absolutely sure to fail ultimately, because it is not based on the proper foundation.

The man who buys the tractor buys it to do his farm work. As a farmer, he is not particular whether it has two wheels, three wheels, four wheels or no wheels—so long as it goes out, performs consistently, runs without breakdowns and gets his farm work done more easily and with less effort on his part than that required under the old method to which he is accustomed.

In working out our tractor designs, we must, as tractor engineers, consider carefully ease of control and ease of operation with reference to the implements which are being used with the tractor. The man who builds a tractor that does farm work—preferably all farm work requiring the application of mechanical power—and does this work with the least effort on the part of the operator, will ultimately get most of the tractor business, and it will not matter, so long as his tractor is easiest and most convenient to operate, if some other company is making and selling tractors for half his price.

FLEXIBLE GAS BAGS FOR MOTOR CARS

A COMMITTEE was appointed in England last November to consider the employment of coal gas as a source of power, particularly in motor vehicles.

In its March report, the committee expressed the view that ordinary illuminating gas can be effectively, safely and promptly substituted for gasoline in engines of the kind usually fitted to motor vehicles, without reduction in the compression space of the cylinder. A mean consumption of 250 cu. ft. of gas, having a gross calorific value of 490 to 500 B.t.u., is accepted as the equivalent of 1 gal. of gasoline. An appendix gives a specification for the fabric to be employed for flexible containers. The normal working life of such containers may be increased by as much as 50 per cent if the fabric is continuously protected from the action of light by a suitable covering. It is undesirable that semi-rigid containers of rubber and canvas, and other fabrics, be charged with gas to a pressure exceeding 90 lb. per sq. in., or have a larger internal diameter than 4 in., and even with these limitations such containers are unsafe unless properly armored with galvanized steel wire of 0.012 in. diameter.

Encouragement, however, should be given to the construction and use of semi-rigid containers of rubber and woven wire up to a working pressure of 300 lb. per sq. in., and to experiments on a commercial scale with compressed gas in rigid metal cylinders, plain or wire wound, at pressure up to at least 1800 lb.

DATA FOR MOTOR TRANSPORT CORPS

THE Society has received from an officer of the Engineering Branch of the Motor Transport Corps, American Expeditionary Forces, France, a request that manufacturers of motor vehicles as well as of all kinds of related equipment place the name of the Engineering Branch on their mailing list to receive such data and printed matter as they may issue from time to time relating to their products.

II—Modern Aeronautic Engines

By HERBERT CHASE* (*Member of the Society*)

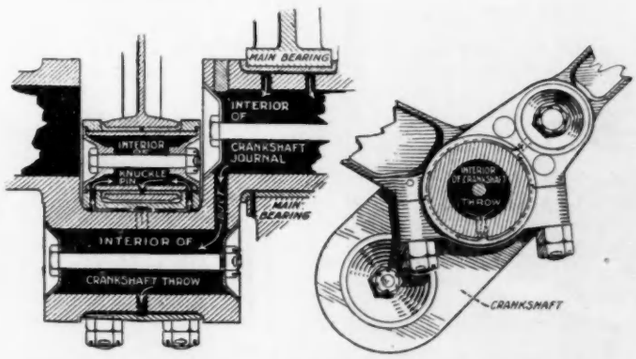
SEMI-ANNUAL MEETING *Report* *Illustrated with* CHARTS AND PHOTOGRAPHS

THE first part of this report, which was printed in the August issue of THE JOURNAL, contained illustrations and brief descriptions of several foreign and American aeronautic engines, these including the Benz and Mercedes (German), Hispano-Suiza and Renault (French), and the Curtiss, Sturtevant and Thomas (American).

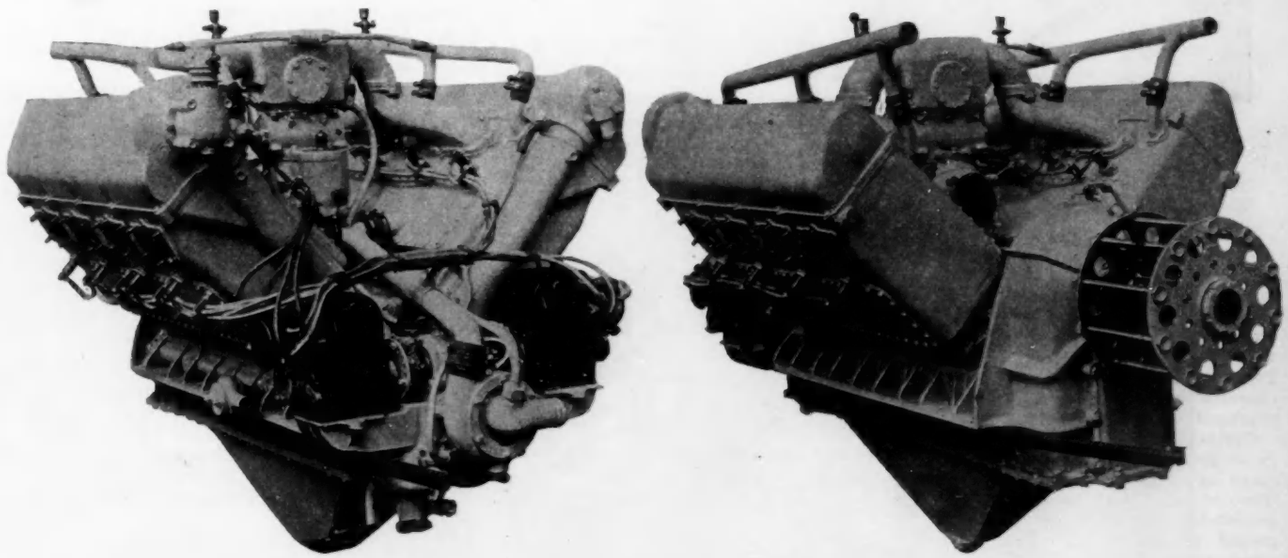
The report is concluded in this issue by the descriptive matter given below; this relates to the Sunbeam and Rolls-Royce (English), and the Hall-Scott (American) engines.

The whole report is based on a talk given by the author at the meeting of the Society held last June in Dayton.

*Assistant Secretary, Society of Automotive Engineers, Inc.



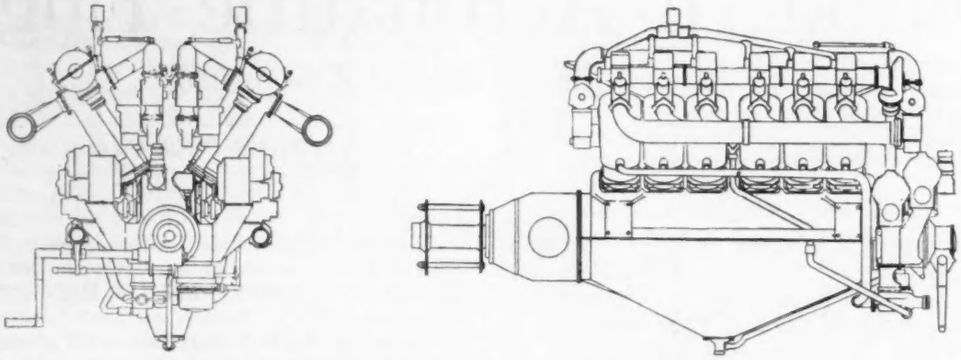
Sunbeam articulated rod. Pressure feed to main and big end bearings. Oil caps on hollow shafts held in by through bolts.



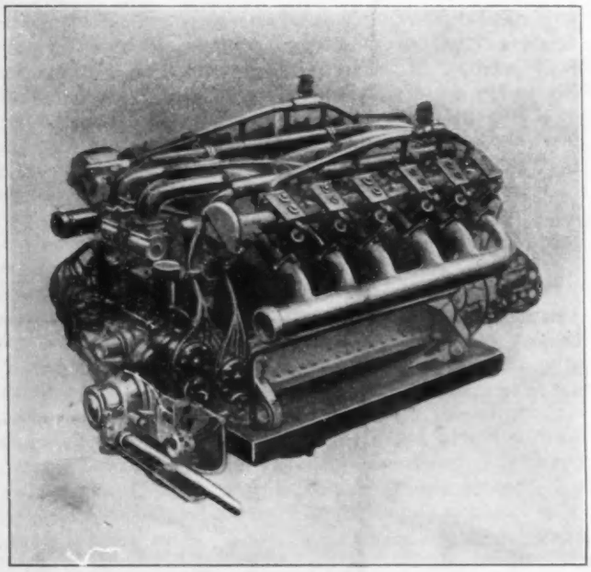
SUNBEAM (ARAB L TYPE), 208 HP. AT 2000 R.P.M.

Bore, 4.72 in.; stroke, 5.12 in. on master-rod side and 5.55 in. on less link-rod side. Eight cylinder, 90 deg. V. (Has given actual 235 max. b.hp. at 2000 r.p.m. Gear ratio, 27 to 45; compression ratio, approximately 5.2. Weight, 550 lb. or approximately 2.5 lb. per b.hp. Cast aluminum block with open end steel liner. Liner flanged at bottom and held between cylinder and crankcase. *Three* valves, one inlet and two exhaust seating in bronze bushings screwed into head.

Sunbeam valves actuated from overhead camshaft, inlet valve cam bears directly on hinged finger, which operates valve and relieves it from side strains. Exhaust valves actuated by rocker arms.



GENERAL ARRANGEMENT OF SERIES VIII "EAGLE" ENGINE



END VIEW OF ENGINE SHOWING MAGNETO LOCATION

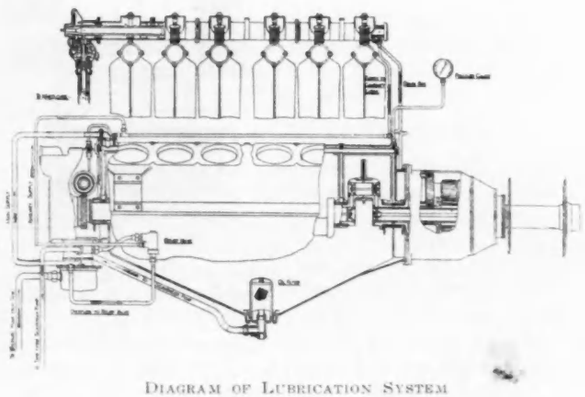
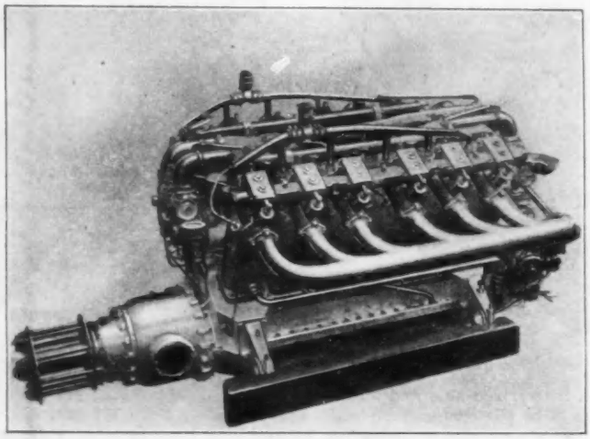


DIAGRAM OF LUBRICATION SYSTEM



VIEWS OF ROLLS ROYCE "EAGLE VIII," AVIATION ENGINE

Bore, 4.5 in.; stroke, 6.5 in.; 350 b.hp. at 1800 r.p.m. Geared, 1.6 to 1. 12 cylinders, 60 deg. V. Weight, 847 lb., or 2.42 lb. per b.hp.

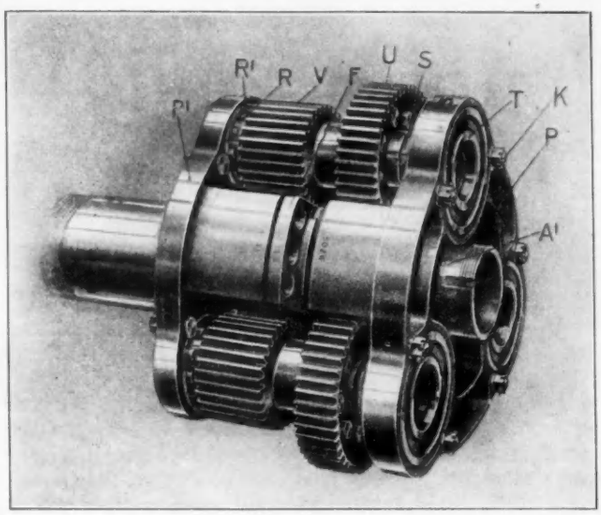
One of the most successful British aeronautic engines. Uses steel cylinders with jacket welded on. Two valves per cylinder, operated by levers from overhead camshaft.

Compact form of epicyclic gear used to reduce speed of propeller shaft. One of the very few geared-down engines regarded as being wholly successful.

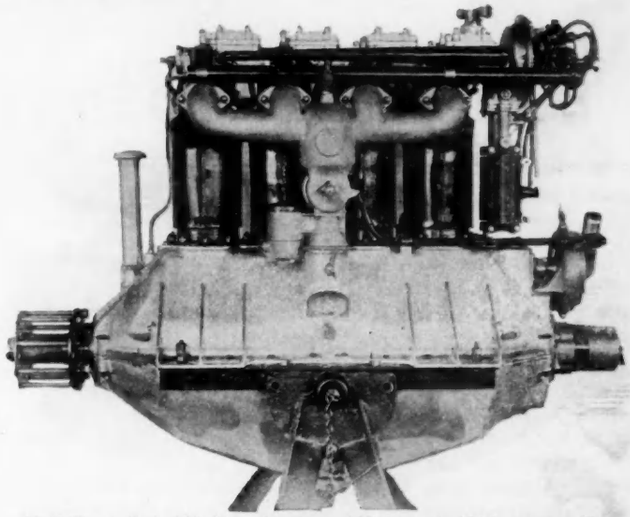
Note four carbureters and four (Watford) magnetos.

Carbureters in V, the exhaust being on the outside.

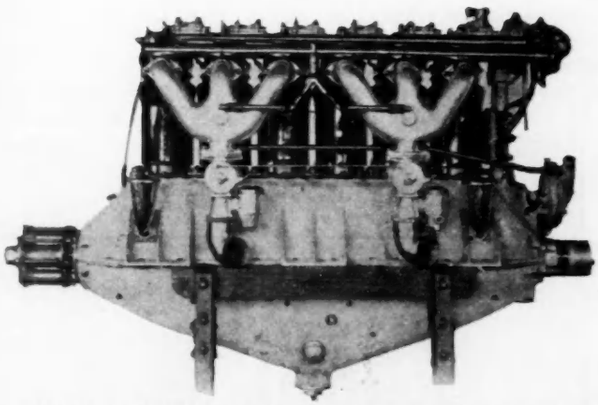
Two gear-type oil pumps, one to circulate oil through a cooler and the second to force oil under pressure to the main, big end, piston-pin and camshaft bearings, as well as to the planetary gear. Articulated type of connecting rods. Pistons fitted with four rings at the top and a scraper ring at lower edge of skirt.

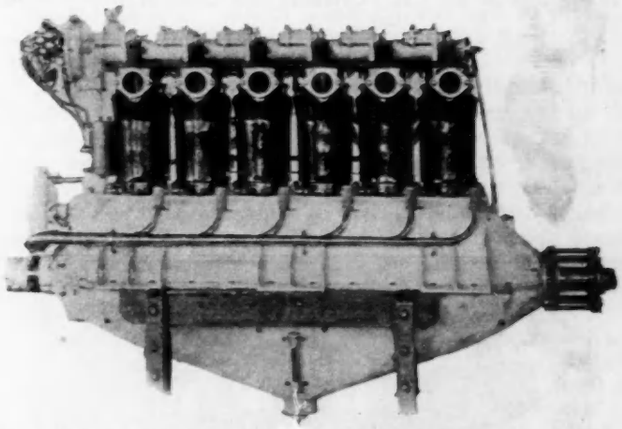


PLANET CAGES USED FOR ROLLS-ROYCE GEAR REDUCTION

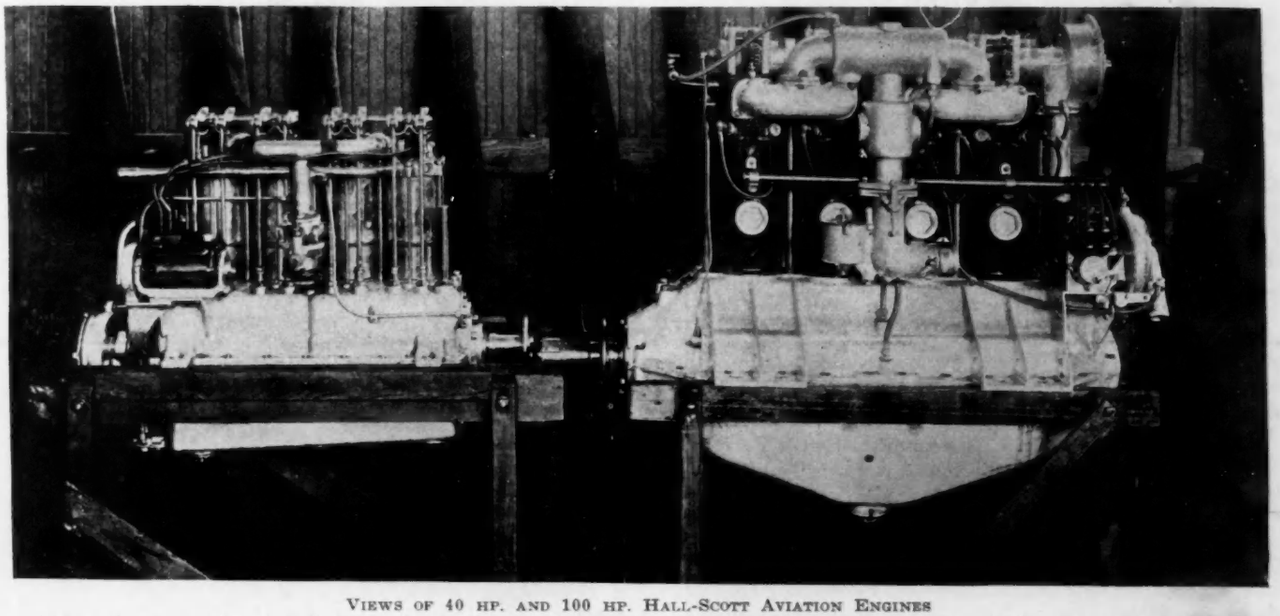


Hall-Scott L-4 125 hp., develops 137 hp. at 1700 r.p.m. Bore, 5 in.; stroke, 7 in.; four cylinder. Compression ratio, 6.55. Weight, dry, 380 lb., or 2.77 lb. per b.hp. Manifold is different from that used in 100-hp. model, but oil system, crankcase, water pump, etc., are similar. Generator in place of magneto formerly used.



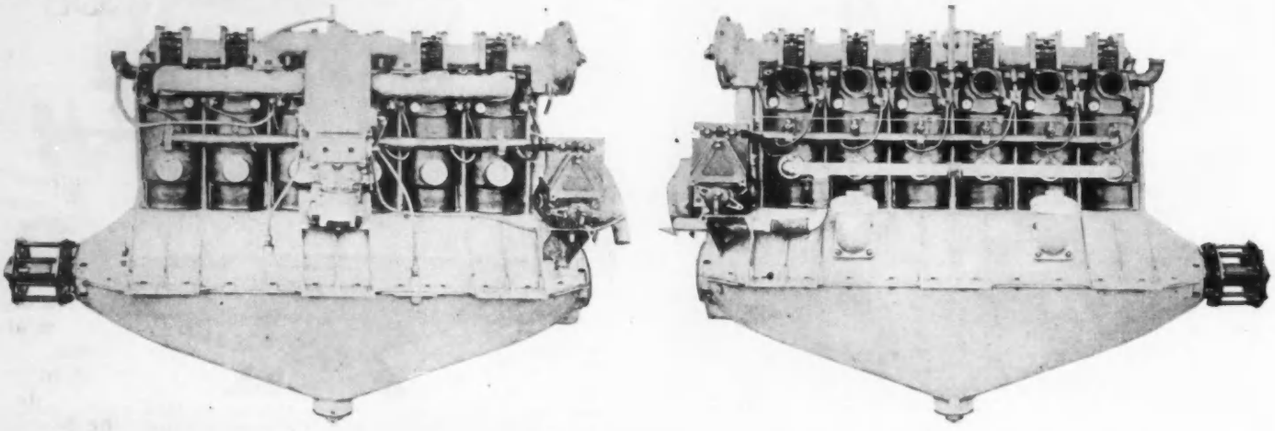


Hall-Scott L-6, 200 hp. at 1700 r.p.m. Bore, 5 in.; stroke, 7 in.; six cylinder. Compression ratio, 6.55. Weight, dry, 500 lb. (including propeller hub and flanges), or 2.32 lb. per b.hp.
Crankcase similar to Hall-Scott A-5-A. Uses generator in place of magneto, and two carbureters in place of one.

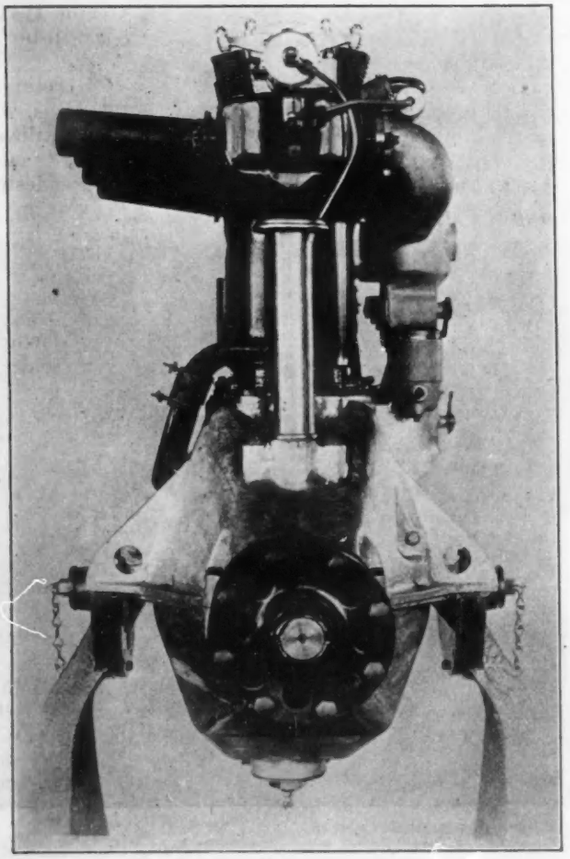


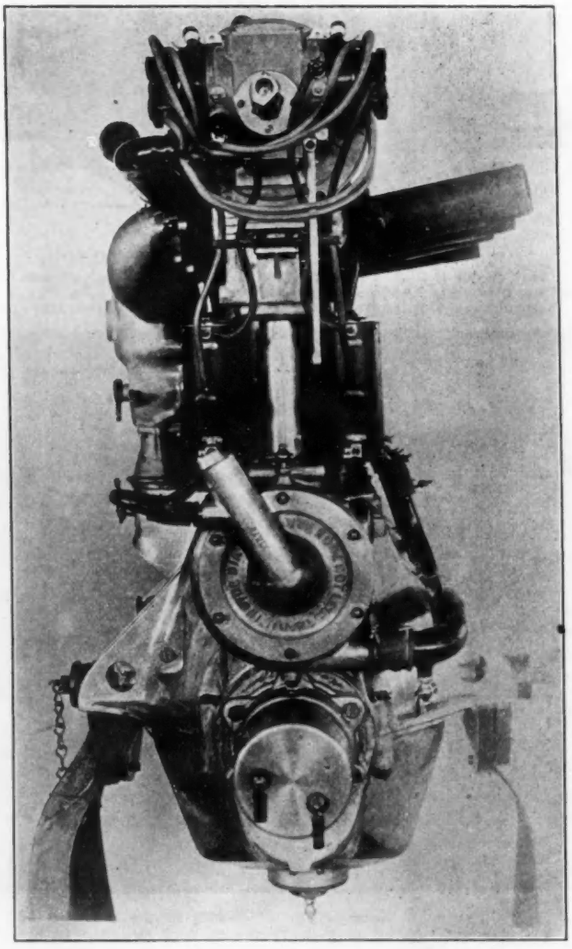
VIEWS OF 40 HP. AND 100 HP. HALL-SCOTT AVIATION ENGINES

The earliest type of Hall-Scott engine four cylinder 40 hp. Used overhead valves actuated by long rods from camshaft in crankcase. Hall-Scott, 100 hp. at 1400 r.p.m. Bore, 5¼ in.; stroke, 7 in.; four cylinder. Compression ratio, 4.67. Weight, dry, 420 lb., or 4.2 lb. per b.hp. Cylinders of cast iron with integral heads and jackets. Rugged engine used extensively in training planes.



Hall-Scott A-5-A, 125 hp. rating, develops 165 hp. at 1400 r.p.m. Bore, 5¼ in.; stroke, 7 in. Six cylinder. Weight, dry, 555 lb., or 3.36 lb. per b.hp. Cylinders cast (semi-steel) with integral head and jacket. Cylinder walls ⅛ in. thick. Magneto ignition.





End Views of Hall-Scott L-4, Showing Shaft End (Left) and Two Separate Ignition Distributor Blocks

Oil-Burning Tractor Engines

By H. T. Sward* (*Non-Member*)

Mid-West Section Paper

THE history of the construction of farm tractors extends back into the early seventies, but it remained for the twentieth century to see the first use of tractors driven by gas and oil engines.

While gas and oil tractors have been in operation for about fifteen years, this has not been long enough, apparently, for designers to gather conclusive evidence indicating the best type of engine. Almost every type of internal combustion engine is being used today, from the low-speed, hopper-cooled farm type of stationary engine to the high-speed automobile engine.

With each of these types the designer must use radically different construction in the general design of the tractor, transmission, etc., and, as a result, it has been difficult for any association to gather sufficient data to develop an engine that can be called a standard tractor engine.

This one fact, perhaps, more than any other, has made it necessary for the purchaser of a tractor to have some knowledge of the product he is buying. He has had to study carefully the various designs, so as not to be the prey of overzealous salesmen.

Special Requirements

In designing a tractor engine, it should be borne in mind that the average user is going to consider seriously the small tractor. He will buy a tractor with an engine which he thinks is large enough, and the tendency has been to buy the outfit which is rated at the highest power and sold at the lowest price. The result has been that the tractor engine is usually loaded to its full rated capacity. It is required to develop its full load or more most of the time in regular service. It is therefore necessary to furnish an engine designed to carry this load without undue strain upon any part.

It has been found in stationary practice that an engine, to show the greatest reliability under all load conditions, and especially where full loads are required for any length of time, must be a slow-speed engine.

Early in the history of the stationary engine several high-speed engines were developed, but all of these proved unsatisfactory for continuous heavy work. High speed necessitated the use of light reciprocating parts, and it was found practically impossible to build these heavy enough to stand the continuous heavy strains and give good service.

A tractor engine, to be successful, must be one that, when placed in the hands of a man of average intelligence, can be operated without unusual difficulties. Also, it must be economical in operation. It should be a constant-speed engine, with as few parts as possible, and free from intricate and delicate mechanisms.

Kerosene the Principal Fuel

The designer of tractor engines is confronted with the problem of successful operation on cheap, low-grade oils. This subject has been studied during past years by the majority of tractor manufacturers, but in some cases it has been treated as a matter of secondary importance. Many attempts have been made to convert an engine designed for gasoline so that it will operate on oil by simply adding a manifold and a specially constructed carbureter.

About ten years ago the first "solar" oil engine was introduced in stationary units. This was practically a dry gas engine. The cumbersome carbureter or vaporizer attached to it was nothing more than a refining retort in which the lighter distillates were released in the form of gas, and the heavy ends and residue precipitated. Several attempts were made to operate, on the heavier oils, engines resembling present automobile engines; these were provided with splash lubrication, but were absolute failures. All of these failures can be directly attributed to the improper handling of the fuel and the failure of the lubricating system.

Progress has been made very rapidly in the oil engine field; it can be stated that more than 90 per cent of the engines larger than 5 hp. manufactured today for farm and industrial purposes are equipped to burn kerosene and distillates as low as 38 deg. Baumé. In order to do this, it has been necessary to discard many well-designed engines, and many practices that were considered standard. This must also happen in the automobile type engine, before real progress can be made in the oil-burning engine for general automotive purposes.

Gasoline engines fitted with kerosene carbureters are not successful; the latter are simply delicate parts, which are supposed to accomplish the necessary volatilization of the fuel. Experience has taught us that this cannot be done by a carbureter, as the engine must be designed to take care of this heavy fuel, not only in the carbureter but during all stages until power has been developed.

Use of Low-Grade Oils

As we have no choice as to the fuel to be used, the designer should consider carefully how the low-grade fuels can be put to use without the difficulties which result with the kerosene carbureter.

The engine which we have used successfully is of the horizontal, two-cylinder, four-stroke cycle type, with compression at about 60 lb. The cylinders are cast in block with a common crankcase, the connecting-rod having a single throw, giving the crankshaft a power impulse at every revolution.

The fuel-mixing chamber consists of a simple casting, in which the fuel is kept at a uniform level by means of an overflow pipe, which returns the excess fuel delivered by a fuel pump to the fuel tank in the base of the engine or tractor frame.

In starting the engine, all the fuel is returned to the fuel tank, and the mixing chamber reservoir, as well as the fuel pipe above the pump, is filled with gasoline. This fuel enables the engine to be started readily, and operated until warm enough to run on the heavy fuels, and the change is made automatically, as the kerosene and gasoline are pumped into the mixing chamber after the engine is in operation.

*Sales Engineer, Fairbanks, Morse & Company

The hot air is taken through a manifold on the exhaust pipe, passing through the mixing chamber reservoir and over the needle valve in the usual manner. Between the mixing chamber and the cylinder head is an auxiliary air intake, in which is provided an auxiliary valve controlled by a helical spring. In this cold air inlet, below the valve, is the water spray nozzle in which the water is kept at a uniform level by a float chamber adjacent thereto. As the load comes on the engine, the governor opens the fuel throttle valve, and this action increases the volume of air, to a point where the regular intake cannot supply the air, and the auxiliary valve is opened automatically to supply the amount of air required for combustion. The opening of this auxiliary valve also automatically controls the amount of water taken into the cylinder, in direct proportion to the load upon the engine, giving a uniform and satisfactory operation at all times.

In an oil engine, it is of utmost importance that the mixing chamber be immediately adjacent to the cylinders and the passages from the chamber to the cylinders be of equal length. In this engine, the chamber is located immediately adjacent to the cylinder head, with the inlet valves to both cylinders directly beyond the throttle valve. All valves are in the cylinder heads, the exhaust valves being on the outside of each cylinder, and the head a single casting for both. This gives a minimum distance for the passage of gases, and insures against condensation due to long conducting pipes to the inlet valves.

Also, the circulation is restricted at the points around the inlet valves and passages, to insure a higher temperature of the water at these points.

Force Feed Lubrication Advisable

Experience has shown conclusively that the splash systems of lubrication cannot be used with heavy oils, such as kerosene and distillates, even with the best of construction. In the present condition of the fuel market, with the gasoline obtainable, the crankcase oil must be renewed every 1000 miles to insure against burnt-out bearings and kindred troubles.

The time is not distant when, for economy as well as satisfactory operation, this system must be abandoned and force feed lubrication to all bearings used universally.

To insure proper lubrication of all parts, tractor engines should be lubricated by the force feed system. I believe it is used almost universally except where automobile engines are employed.

Novel Cooling System

The cooling system of the engine is novel, but nevertheless has proved itself to be among the best used. The main frame of the tractor looks much like a steam boiler. This is a large radiator, with tubes, through which the air is drawn in quantity directly proportionate to the load on the engine.

The exhaust from the engine is piped to the chamber in front of the radiator, and in making the discharge through the smoke-stack shaped muffler, creates a draft through the radiator which keeps the water at a uniform temperature.

Circulation is maintained by means of a circulating pump driven by belt from the engine flywheel.

Ignition System

Electrical ignition, of course, is used, and in this particular engine it is the high-tension system. The type of ignition is purely a matter of choice, but with engines operating at a speed from 400 to 600 r.p.m. we have found that the high-tension system is preferable; it is difficult to get good operation with the make-and-break system owing to the rapid motion of reciprocating parts.

THE DISCUSSION

Chairman George W. Smith (M. S. A. E.):—Some tractor people will, I believe, take issue with Mr. Sward on the possibility of carbureting kerosene fuel, although a number of them claim to do it. I am not sure how the fuel-mixing mechanism functions. It seems the hot air is taken in through the manifold, passes the chamber where the fuel is held, boils the fuel, and carries it in along with the air.

Dent Parrett (M. S. A. E.):—In spite of the statements in the paper, there are some four-cylinder engines burning kerosene successfully. I heard of an interesting experiment that has been worked out in the design of an engine in which the fuel is taken in with the cold air; with the proper design of cylinder and piston, part of the heat from the former explosion is retained in each charge, thus increasing the volumetric efficiency of the engine. We are able to burn kerosene, but the heating of the charge reduces the power output of the engine. However, this is not serious.

A Member:—In the case mentioned by Mr. Parrett, we were unable to avoid a slight loss of power even by taking the air cold. That might have been due to the fact that the gases were too warm. While we lose from 10 to 15 per cent of the available horsepower with cold air, we have found the greatest trouble is due to the operator in the field changing from gasoline to kerosene before sufficient heat is acquired. There should be very little difficulty in handling kerosene; the difficulty is in educating the operator to use it intelligently.

J. G. Zimmerman (M. S. A. E.):—In traveling around the country and visiting different people I have found that same situation. Lack of education on the part of the user more than anything else causes the inefficient use of kerosene. In one particular instance it was nothing more nor less than the ground wire that prevented the magneto from generating sparks. The farmer had everything wrong with the tractor he could have wrong. The engine had been out in the cold all night, but he switched off the gasoline immediately after he got the engine started. After a little instruction he had better service. Then he did not change over to kerosene until his engine was warm enough to run on kerosene.

Henry Farrington (M. S. A. E.):—I have come in contact with many engineers throughout the country and their opinion is that the trouble in operating on kerosene is with the engine manufacturers. Up to the present time engine manufacturers have had a large market for automobile engines, and later in motor truck engines, and they have not considered developing a type of engine to operate with kerosene.

With gasoline at 9½ cents a gallon we did not consider whether we used low-grade or high-grade fuels, and engine manufacturers did not bother about kerosene-burning engines. The result has been that tractor manufacturers who were unable to build their own engines have had to use engines not designed to operate on kerosene. Latterly, however, several engine manufacturers have designed special kerosene-burning engines for tractor work exclusively, and are meeting with success.

Changes in Engine Design for Kerosene

A Member:—At the S. A. E. tractor meeting in Fremont last year it was pointed out that essential changes

were needed in the design of the engine and that no gasoline engine would operate efficiently on kerosene, even with the best kerosene carbureter. If engine manufacturers would make a few changes, notably putting more cooling space in the cylinder head and even water-jacketing the spark-plugs, they would secure better results. I understand that one company has recently developed such an engine and is having success with it.

D. L. ARNOLD (M. S. A. E.):—The burning of kerosene does not seem to be particularly difficult. Many engines on the market today will start on less than one ounce of gasoline at ordinary temperatures under every-day atmospheric conditions. With proper care, automobile types of engines run successfully; it is simply a matter of education.

So far as water is concerned, I do not believe anybody knows just what happens. With the use of water the timing of ignition is changed, but more power is obtained from an engine of the same bore and stroke, provided the other necessary minor changes are made, than would be obtained without its use. As far as the cooling is concerned, the kerosene engine will use less water for cooling than the gasoline engine.

Engine Regulation

Standard makes of engine will operate on a speed regulation of 3 per cent from their rated speed, without adjustment of the engine. If when running under full load, say 20 hp., the load is suddenly released to no load at all, there will then be a 3 per cent speed regulation.

CHAIRMAN SMITH:—Then the engine functions as well with the throttle closed as open?

MR. ARNOLD:—After running all day the engine will pick up the load without a miss. This has been done on a 25-hp. engine and the engine would not miss.

A MEMBER:—What method of governing is used to get that 3 per cent regulation?

MR. ARNOLD:—The ordinary fly-ball type; it is simply a case of getting the springs right.

A MEMBER:—Is it not a question of regulating the oil to make kerosene work properly? It was stated that by regulating the lubrication properly good results are obtained. I suppose more oil is used.

MR. ARNOLD:—Not necessarily more, but a different grade. Gasoline is a fuel which ordinarily burns much more cleanly. When a poor operator starts a "green" engine, the kerosene goes by the piston, cuts the lubricant and causes trouble.

A MEMBER:—One has more trouble in winter using kerosene?

MR. ARNOLD:—There is less, especially with heavy grades of lubricating oil.

MR. ZIMMERMAN:—With multiple and one or two-cylinder engines, is there any advantage over the single cylinder type?

MR. ARNOLD:—So far as fuel economy is concerned, there is little choice between a four-cylinder and a single-cylinder engine. It is hard to say whether the multi-cylinder engine will last the longer. That has yet to be proved.

Tractor Life Varies Greatly

A MEMBER:—What is the life of a tractor engine?

MR. PARRETT:—Circumstances vary so much under similar conditions that the life of a tractor engine may vary from a few days to years. We have had experience with four-cylinder engines; in some cases they have gone to pieces in two or three days—in all such cases because of dust. Better protection against dust will mean a great difference in the life of engines. I do not know that it makes much difference whether engines have two, four or six cylinders.

In some localities the tractors do not run over twenty-five days a year; in other places they are used half the year. Tractors working at certain times of the year in some localities give excellent results; the same tractor in other localities and at other times of the year give a great deal of trouble. It is hard to express in definite terms the life of any machine.

A MEMBER:—A statement has been made that the average tractor lasts only a year. Among the farmers we find this has been the general experience. There is a feeling that the tractor is not as reliable as it should be.

A MEMBER:—Legitimate tractor manufacturers are giving better service than that. I have used a tractor for three years and my expenditures for repairs at present are less than $75.

CHAIRMAN SMITH:—I have seen tractors standing out in the field without other covering than five feet of snow. A tractor so treated would last about a year and its owner does not deserve to have it last longer than that. Given proper care, I am sure the tractor will give as good life as other machinery of like nature.

NEW MEMBERSHIP ROSTER ISSUED

THE 1918 Membership Roster of the Society has recently been printed, and a copy will be sent without charge to all members of the Society who make a request for it from the New York office. The Roster is practically the same size as the membership list issued about a year ago, although the membership of the Society has increased largely. Much of the general information given in last year's book has been omitted. This general matter consisted of the Constitution and information regarding the activities of the Society, and can, it is felt, be given to members desiring it in some other form.

An entirely new feature of this year's book is the geographical register. The alphabetical list of companies and members connected therewith is retained in the present issue.

Since the last list was issued the number of individual members of the Society has increased from 2593 to 3326 members. The most important increase, however, is in the number of companies represented in the Society. Last year there were 1179, while in the new book 1527 companies are represented by members in the organization. The number of universities and institutions of learning represented in the Society is more than doubled, being last year 11 and this year 25.

In addition to the data relating to individual members, an up-to-date list is included of the administrative committees, the Standards committee and the Section officers.

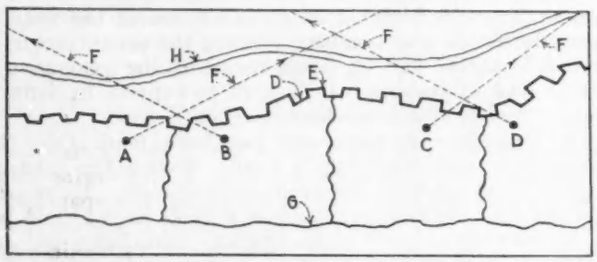
Since the Membership Roster is intended in part for the use of applicants for membership, a brief introduction is included, suggesting methods by which the applicant can find the names of members familiar with their professional experience.

Tanks In Modern Warfare

By E. H. KINDER* (*Non-Member*)

PHILADELPHIA SECTION ADDRESS *Illustrated with* CHART

THE French have developed the idea of flanking fire, and trenches are now built as shown by the sketch. The part *E* is called the firing trench. The traverses are marked *D*. They are quite irregular, as will be seen, and have been constructed in that way to develop what the French call flanking fire. They will place machine guns at *A* and at *B*, and extending the system, the guns are so placed that they create a belt of fire *F*. Positions *A* to *B*, *B* to *C*, etc., are known as strong points. A modern machine gun fires at the rate of about 400 shots per minute, and an infantryman trying to cross a belt of fire of that kind meets sure doom. One can get through a barrage but not through machine-gun fire, which traverses about one foot above the ground. A man could not even crawl through.



FLANKING FIRE AS EMPLOYED IN TRENCH WARFARE

In an infantry attack the first step is the preparation. A barrage is placed on the enemy lines, and while that barrage is in effect it is impossible for the enemy to remain in the trenches. A second line of trenches back of the first is called the support *G*. This is well equipped with strong dugouts. During the barrage the infantrymen of the enemy are back in the line of support and in the dugouts. Machine-gun emplacements are generally very closely associated with dugouts. They are generally found close together for the sake of the machine gunner. As soon as the barrage lifts it is very important that the machine gunner and crew get out quickly. This is so carefully timed that almost the minute after the barrage lifts the machine gun is out there ready to work. As the attacking infantry move forward the machine gun is waiting for them. A barbed wire entanglement is encountered at *H* and they have to take out the front of this. When the infantrymen get to what is to be the belt of fire of the gun it opens up. As soon as the machine gun starts to work it is impossible for the infantry to move forward; thus we can see where the tank does its service for the attacking party. It is the tank's work to destroy these strong points. Tanks are immune from machine-gun fire owing to their armor. Airplane reconnaissance has made it possible for the Allies to locate practically every machine-gun emplacement of the enemy. In placing his machine guns, the enemy takes advantage of shellholes or other conditions caused by the barrage, but that cannot always be figured out. In any case, with tanks leading the attack it is very easy to destroy a strong point.

TANKS EMPLOYED FOR COMBATTING STRONG POINTS

The tank, considered as a tracklaying tractor, is an American product, and it is purely an offensive weapon. It was designed to combat the strong points.

The tank is practically a walking arsenal. It takes only one well-placed shot to put that machine gun out of business. The tank is purely an offensive weapon; it is a destroyer of the enemy's strong points, making possible an advance through machine gun fire. This use of machine guns is a French idea. When the French take a set of trenches the first thing they look for is a place to put the machine gun. Once placed, it relieves the men in an entire line of trenches, making it possible for them to get into the dugouts. One sentry and a machine gun will protect the front for 500 yards, and the tank is designed to combat just such strong points and to make possible an attack by infantry.

The American Tank Corps is in its infancy. In creating the corps the War Department first made it a part of the Sixty-fifth Engineers, calling it the Tank Service, and allowing it as an organization to pick two per cent from every military camp in the country. In this way the men best qualified for the work are secured—among them mechanics, chauffeurs, truck drivers, machinists, blacksmiths, cooks, etc., and the necessary auxiliary force, such as stenographers and typists, incidental to every fighting force. These form the nucleus of the Tank Corps. Now it has become necessary to get about 2000 more skilled men of such vocations as I have mentioned—blacksmiths, chauffeurs, truck drivers, cooks, wireless operators, machine gun mechanics and general machinists. They must be skilled men because their task will be to instruct the recruits and the soldiers taken from other camps who are not as yet mechanically trained. They are not soldiers, but with very little training they become soldiers. These men are put through a certain course of instruction so that when they come to train the recruits their ideas will be uniform. This is necessary, because they have worked in different places in civil life and have different ways of handling, say, gasoline engines, wireless outfits, and of keeping books. The Army makes it a point to have all things uniform, so far as this is possible. They put these men through two or three weeks' training in some school, give them a course of instruction, and teach them as they want the men taught. All the men have had practical experience and can very easily pick up Uncle Sam's way of giving this instruction. Later on, I understand, there will be a call for 5000 more of these men. We are now taking men from 18 to 46 years of age, and selecting those especially qualified.

*Second Lieutenant, Tank Corps, N. A.

I—Outstanding Aeronautic Problems

By Dr. W. F. Durand* (*Non-Member*)

TEN years ago the airplane was a curiosity—a means wherewith, by a *tour de force*, a man might lift himself from the ground and make a hazardous flight through quiet air—a means to attract curious crowds to fenced-in country fair grounds to witness the marvel of a body heavier than air actually rising from the ground and moving under some measure of control through the air, and returning safely to its starting point.

It is perhaps well within the limits of conservatism to say that no achievement of man's inventive and constructive genius has undergone more intensive, more rapid, or more potentially significant development than has that of flying with an apparatus heavier than the air in which it moves.

It may be further noted that perhaps no technical and constructive achievement of man has ever called more largely on science and on the aid of scientific research to aid in the solution of the many problems which have presented themselves in the course of this astonishing development in aerial navigation which the past decade has witnessed.

In the circumstances which have determined the direction and character of the development of the airplane during this decade, and especially in those which have been controlling during the past three or four years, it is only to be expected that at the present moment we should find ourselves with many problems partly solved, with others which we have hardly more than begun to attack on the outskirts, and confronted by still others, the character and significance of which we have hardly begun as yet to apprehend.

On the present occasion we may find it not without interest to pass briefly in review some of these problems, noting their present status together with such indications as may in some cases serve to point the way toward a possible solution.

Problem of Constructive Materials

Perhaps nowhere is there to be found a better illustration of the interdependence of technical and scientific research and study than in the manifold advances on various technical and scientific lines which conjointly have made the airplane in its present form a structural possibility.

Broadly, the modern airplane comprises a body of some sort or form fitted with wings to provide the supporting surfaces, with a prime mover or source of power and with a propeller of some type to transform the power provided by the prime mover into propulsive work, and, by the reaction of the relative air stream on the under side of the wings, to secure the sustaining or lifting force necessary to carry the weight. This construction calls for a wide range of constructive materials. Thus the body and wings, comprising the airplane proper, require the following fairly distinct classes of structural elements:

(1) Those intended primarily to give form, strength and coherence to the structure. They represent in effect the skeleton or foundation on which the entire function of the plane as such must depend.

(2) Various secondary elements intended so to tie or connect the principal members together as to secure homogeneity of structure as a whole, and mutually responsive action on the part of the different elements comprised under No. 1. The elements here considered are those which, from a purely structural viewpoint, may be classed as struts and ties or tension members.

(3) Surface covering for the body and wings. This gives outer form and continuity of surface and provides furthermore the actual surfaces on which the air lifting and supporting forces may act.

Broadly speaking, the fundamental problem in all plane construction is adequate strength or function on minimum weight. In no other form of engineering construction is the necessity for weight saving so rigorous. In a very real sense every ounce of material entering into the structure must be able to show a competent passport. The structural problem of the plane is therefore one of strength in relation to weight. For the main elements comprising the skeleton of the structure wood has, thus far, held the main place, with metal construction steadily attracting more and more interest and assuming a place of growing importance, at least in the study of new designs.

It is not necessary to our present purpose that we should consider in detail present practice in plane construction. The trend of development since the earliest days of the art has tended to show that wood construction under suitable design and safeguard is able to provide the easiest and, on the whole, the most satisfactory solution of the many problems and requirements which plane construction presents, and so we have been content, for the most part, with this type of construction.

We may, however, be well assured that however good may be any solution that we may reach of the many problems presented to us in the industrial arts, there are, as a matter of fact, series of better ones only awaiting patient study. This is indeed a fundamental truth of which we should never lose sight. We may be, for the moment, satisfied with our solution of a problem in technical industry; we may be able to see nothing better, and yet we may be well assured that, as a simple matter of fact, there is something better. This is a perfectly safe assertion, if only as based on the law of probability of our having, at any given time, reached the final optimum possible combination capable of furnishing a solution of the problem.

Thus, as applied to the problem of constructing the framework of the fuselage of a plane or of combin-

The Sixth Wilbur Wright Memorial Lecture, read before the Aeronautical Society on June 25, 1918.—From July 3, 1918, issue of *Aeronautics* of London. The second section of the lecture will appear in the October issue of The Journal.

*Chairman of the U. S. Advisory Committee for Aeronautics.

ing wing spars and ribs in such manner as to form a wing skeleton, we may be sure, however good our present practice and however satisfactory it may seem, that in reality it is not the best, and that long series of better solutions only await our intelligent and patient study.

In this and in all such problems there are always two fairly distinct though inter-related parts:

(*a*) What materials are best suited to the purpose in view.

(*b*) What disposition shall be made of the materials adopted.

Thus, in the case of the fuselage, granting wood material be adopted, there remains the question as to the very best distribution of such material as between the main longitudinal elements or longerons, and the intermediate elements; also as to the extent to which reliance may be placed on the outer covering, especially if of plywood. What plane designer can feel sure that, even with given materials, he has reached the optimum distribution of function as between the main and secondary elements of the fuselage and of a plywood outer covering?

Much less, what airplane designer can feel any confidence in having now reached an optimum combination, once we admit the possibility of metal construction, or of some combination of metal and wood, with all the possibilities of the new light metal alloys and of the new alloy steels with their astonishing physical characteristics?

So far as conditioned by the application of the ordinary loading tests, static in character, and aside from the possible results of dynamic attack, shock, long-continued vibration, etc., we may perhaps frankly admit that at the present time metallurgy is able to supply us with material, either in the way of light aluminum alloys or special steel alloys, which, if properly used, will enable us to meet all such static tests in airplane construction, and on even terms or better as regards weight compared with wood.

If such be the case, it certainly stands before us as a problem for the near future to pass in review most thoroughly the entire range of constructive materials, metallic as well as wood, and to determine, in the light of the experience which we are so rapidly accumulating during these days of storm and stress in military aeronautics, the combinations of materials which may serve to give the most efficient service on the minimum of weight.

In connection with this search for new and better materials must go hand in hand the search for better modes of combination in the structure—in other words, better structural design. It goes without saying that the best general type of design, in the way of the distribution of materials, forms and proportions of members, etc., will vary with the class of material employed. There must be some optimum design with wood. There will likewise be another and undoubtedly a different optimum design in the case of steel, and again different in the case of aluminum or other alloys. Thus the search for the best final combination is a search for an *optimum optimorum;* for the best possible material and for the best possible design using such material.

What order of saving may be looked for in the near future from any such search it is, of course, idle to predict. Could we, however, approach somewhat closely to the best use of the best combination of materials even now available in the field of engineering construction and without waiting for new and superior materials which the metallurgical art will doubtless be able to furnish, it seems not unreasonable to anticipate the possibility of a marked saving in weight without loss in strength or security.

This, then, stands out as one of the great problems of aeronautical engineering: that of the best materials and of their best use. Much has already been done, but much yet remains, and rich rewards most assuredly await patient and well-directed work in this field.

The Problem of Size

One of the most interesting of the problems presented to the aeronautical engineer is that of the limiting size and carrying capacity of airplanes. Is there such a limit? If so, what is it? Why is it? And how may it be removed or extended?

In dealing with this problem we come, of necessity, into contact with the laws of similitude of geometrically similar structures. It is well known that under simple modes of loading geometrically similar structures of wing and fuselage will have similar factors of safety under equal unit loads. But for such structures, if strictly similar geometrically, the weights themselves will increase as the cubes of the similar dimensions, while the areas of wing or supporting surface will increase only as the squares, and hence the ratio of weight to area will continuously increase as the linear dimension.

In these circumstances it is readily shown that, in accordance with the relation of the factors involved, there will be, for any given speed, some size for which the lifting capacity over and above the structure itself will be a maximum, and above which the lifting capacity over and above the structure will become less and less with increase in size, gradually reaching zero for some value of the size of the structure. This would mean that at such point the supporting force developed at the speed in question would be just enough to lift the structure itself from the ground, but with no reserve for additional load.

This is, of course, a definite law derived from well-known principles of geometry and calculus, and if it were the whole story it would indeed tend to raise an insuperable bar before continued expansion in size. If such were the case it would mean in effect that increase in lifting capacity could be reached only by the following measures:

1. Reducing to a minimum the relation of weight of structure to area. That is, general improvement in the program of design and reduction of weight of structure in relation to supporting surface.
2. Reducing to a minimum the resistance of the plane at the given speed and likewise the relation of weight to horsepower.
3. Raising to a maximum the relation of lifting force to area, consistent, however, with the decrease of the total propulsive resistance of the plane.

Were we indeed subject, without recourse, to the operation of this law of mechanics and geometry, we would be in a sorry state regarding the future development of the airplane as to size and carrying capacity. We would be limited strictly within the bounds of the developments made possible by improvements and advances along the lines as indicated above. But, fortunately for the future of aerial navigation, we are not so limited, and there seems no reason why, at the present time at least, we should need to anticipate any especial limit as necessarily imposed on airplane construction, as regards either size or carrying capacity.

We are able to escape from the consequences of this law due to two facts:

1. It is not necessary that a large element of a plane, a wing in particular, should be geometrically similar in structural characteristics to a small one. For a certain size the structural elements will partake of certain characteristics. As the over-all size increases, these elements may take on new characteristics. Those which had been solid may now become hollow or of lattice or built-up form. The law of geometrical similitude will not hold, and the weight will not necessarily increase in ratio with the cube of the over-all linear dimensions.

2. It is by no means necessary that a large plane shall be, in its general form, a geometrical copy of a small one. While both will have similar elements, such elements need not be the same in number or arrangement.. In fact one of the most obvious of means for increasing lifting power is to increase the number of the wings or lifting elements. There is no reason, at least structurally, why wings and connecting elements should not be increased in number beyond anything now in use or even considered—increased to a point which would give a size and lifting power great enough to meet any demands which we can now formulate or which the future seems likely to present.

Structurally, therefore, the problem of increased size presents three problems as follows:—

1. The structural problem of so developing the character of the elements of plane construction, such as wing spars, longerons, struts, ribs, that with increase in over-all dimension the weight shall not increase sensibly faster than as the square of such dimension.
2. The structural problem of combining the larger elements of plane construction, such as wings, fuselages or engine nacelles, with their connecting structures, in such manner as to secure, for a given wing area the minimum weight of secondary structure.
3. The aerodynamic problem of combining multiple wing elements in such manner as to reduce to a minimum the interference of one with another. This is a problem which opens fascinating possibilities to the student of experimental aerodynamics—a problem on which already some beginnings have been made, but one far from a final or as yet wholly satisfactory solution, and one on which the future development of greatly increased size and carrying capacity seems destined to largely depend.

In short, then, so far as increase in size is concerned, there seems no reason to apprehend any particular limit, or any serious difficulty on the part of the scientist and the engineer in meeting the demands of the future in these respects. The difficulties seem no greater than those which have been overcome in the case of ocean shipping, as shown by the continuous development from the early beginning of the application of engine power to ocean navigation during the first half of the last century down to the mammoth floating structures of the present time; and if we may take any indication from the accelerated rate of progress which has characterized the entire history of aerial navigation, we may feel confident that we shall not have to wait a half or three-quarters of a century for a parallel development in the latter field.

Variable Wing Area or Camber

To mention only one of the many remaining problems which are connected with the design and construction of the airplane itself, a word may be said with regard to the problem of variable wing area. Broadly speaking, the ideal plane should be able to change its wing area in accordance with the conditions and circumstances of flight. For ease in getting off the ground at a moderate speed, for ease in landing likewise at a moderate or low speed, there is need of a relatively large area of wing or supporting surface. For the attainment of high speed, reduced wing areas are needed, and are furthermore sufficient for the support of the weight at such high speeds. The supporting force gained by a given form of airplane wing depends on the area, the speed and the angle of attack, and there will be some combination best for each set of conditions. To meet these conditions, varying from time to time throughout the course of a flight, a correlative variation in wing area is needed.

To some extent the same ends may be met by changing the camber or curvature and form of the fore and aft section of the wing.

Thus, when the camber or fore and aft curvature is increased, the form will be more suitable for landing at a reduced speed, while with curve flattened and camber reduced the form will more readily favor the attainment of relatively high speed.

The problem of an adjustable wing, either as to extent of area or camber or both, is a favorite one with students of aeronautics, and we may hope for some measure of useful and practical solution. Thus far, of the many devices and forms proposed, none has fully justified itself as an altogether satisfactory and practicable solution of the problem.

Motive Power

Passing now to the motive power and its application to the propulsion of the plane, a most interesting and important series of problems challenges our attention. Only the more important can be noted here.

Fuel for Aerial Navigation

One of the most important of these is that of fuel. What is to be the future fuel for the plane, or for aerial navigation in its wider aspects? How long will our stores of crude petroleum, from which we now obtain our petrol or gasoline, as it is variously termed, continue to furnish this all-important element in the present program of power development? Doubtless there are large stores of petroleum yet undiscovered, but we may safely assume that we are using up a supply in the nature of a bank deposit. We are using our principal and not living on the interest. So far as we know, Nature is not now engaged in making for us petroleum, certainly not in any proportion to our rate of expenditure. To such a general program of consumption, there is, of course, but one end, ultimate exhaustion. This is, of course, only one phase of the overshadowing menace which the modern social and industrial world must face some time when our present supply of carbon and hydrocarbon fuels begins to become exhausted, unless indeed we develop or discover in the meantime some other source of energy which will adequately take their place. This is, perhaps, a question which need not seriously concern the present generation, but when we take a long look ahead—a look, for example, as that covered by the development of Europe from the days of the Cæsars, or even from the time of, say, Galileo—we may realize with startling emphasis the need of foresight with regard to a source of energy adequate to the world's demands.

Various ages have been designated as of stone, bronze, etc. The present might well be designated as that of natural energy. Our entire civilization, in a material sense, rests upon the utilization of sources of natural energy which are not inexhaustible, and which are, in fact, becoming exhausted, in some cases with menacing rapidity. In the meantime we must, and presumably we shall, make some shift to tap efficiently other sources now known, or we may happily discover sources which today lie beyond our present vision.

A long look ahead for aerial navigation, therefore, shows that if the present line of development is to continue, there will be a serious problem to be met some time, and that perhaps before many decades—the problem of a fuel suited to the needs of aeronautical prime movers, at a time when present petroleum sources will no longer yield the supply which we now accept and use with so little thought for the morrow.

But with regard to the question of fuels, we need not go so far afield as to look into the coming decades for interesting and important problems. Perhaps the one most pressing for present solution is the question of what is the best fuel for the modern aviation engine, having in view the three requirements—power, economy, with reliability and durability. Out of the exigencies of the present war have come many serious and extended researches relating to the problems of military aviation, and of these none is perhaps of greater significance regarding the future of commercial aviation than the studies which have been made regarding aviation fuels. While matters relating to the problems of military aeronautics must be spoken of with much reserve, it will perhaps be permissible to say that from these studies three principal results seem to have been rather definitely established. These are:—

a. As between the various grades of aviation motor fuels which have been used during recent years, and comprising a rather wide range of composition and of physical and technical characteristics, there is but little to choose from the standpoint of power or economy alone. This assumes, of course, that the fuel is a genuine motor fuel, and the results regarding power or economy relate to an assumed period of effective operation under such fuel. It must not, however, be assumed that there are *no* differences in power or economy traceable to the fuel employed, for such is far from being the case. It is, however, within the limits of reasonable statement to say that such differences are relatively small, and in most circumstances would not, of themselves, constitute a determining or controlling factor.

b. As between such motor fuels marked differences do seem to be indicated as regards their influence on the life and reliability of the engine, especially on long time tests, or in actual service on long time flights.

c. For the various fuels, in order to realize the best results either as regards power, economy or life and reliability, special and individual carbureter adjustments are necessary, and such as can only be determined by trial under actual working conditions.

It may, perhaps, be further said that the problem of an excellent and reliable fuel for aviation purposes seems to have been satisfactorily solved. Its specifications and range of characteristics, physical and chemical, are well established, and so long as our source of motor fuel supply is to be found in petroleum derivatives, we seem to have reached a reasonably satisfactory determination of the best combination of such derivatives for the various requirements of aviation service. These characteristics, which must be considered as a part of the great body of military information, and which cannot for the moment be put down in plain print, we may hope will, in due time, become available in the arts of peace and for the development of commercial aviation in its various fields of promise.

With the problem of fuel that of the prime mover or engine is closely related. Is the present type of engine to continue, or is it only a passing stage to some more perfect form? This is a question, interesting indeed for speculation, but hardly to be considered in comparison with actual present-moment problems. The present engine and its application to the propulsion of the plane does, furthermore, present no lack of interesting and important problems, and among these a few of the more pressing may here be noted.

First, the problem of gross power. How much power can we put in a plane or airship of no matter what type or form? This divides immediately into three subsidiary problems, as follows:—

1. How much power from a single cylinder?
2. How many cylinders for a single engine?
3. How many engines for a single airship?

In the way of power per cylinder we are now reaching close to 40 hp. as a maximum.

In the way of cylinders per engine we have reached a stage of development where the 12-cylinder engine is quite a standard type, and higher numbers, such as 16 and 18, represent only questions of detail. It is not too much to say that the 600-hp. engine is quite within the reach of present practice and may be realized as called for. We have long since become accustomed to two or three engines on a single plane, and are now seeing four engines in recent designs. It is therefore clear that if a powerplant of 2,500 hp. on a single structure is wanted, it is quite within the scope of present practice to realize and provide such a plant.

And if four engines of 500 or 600 hp. each, there is no reason why the number may not be increased, at least to a point beyond the present apparent need for power on a single structure.

On the other hand, it must be admitted that, having in view the limitations of present practice, the most simple and in fact the only reliable way of extending power is by a multiplication of the number of cylinders rather than by an increase in the size of the latter. The fact that a 2,000-hp. equipment would presumably require from 40 to 60 cylinders shows the formidable degree of multiplication of small elements required to realize such a result. The real problem of size or capacity of engine is therefore one of power in a single cylinder. What can be expected in this direction, and in what way shall search be directed?

The present limitation arises largely as a matter of cooling, and it is in this direction that search may well be made for ways and means of effectively increasing the power capacity of a single cylinder in an engine of the aviation type. This is a problem which is distinctly outstanding and well worth our serious attention and study.

Operation of the Carbureter

Another problem connected with the engine is that of the carbureter. At the start of aeronautic engineering

the carbureter naturally took its initial form and arrangement from the already fairly well developed automobile engine carbureter. This was but natural, since both engines are of the same type and both use the same general form of fuel. In respect of the conditions of operation, however, there is a marked and important difference. The automobile operates at or near a fixed level, and hence in an atmospheric medium of sensibly fixed pressure and density. With the plane the case is very different. The latter may change its level by thousands of feet in a few minutes or even seconds, as in vertical or nearly vertical dives, rapid spirals, etc. This difference in the conditions of operation introduces a factor of distinct significance and of great importance in the design and disposition of the carbureter. Experience in the air has clearly shown the importance of this new factor, and it is not too much to say that the problem of the entirely satisfactory carbureter, capable of automatically answering to the various atmospheric conditions under which it must work, is distinctly an outstanding problem. It is true that much progress has been made, and as the result of laboratory research, checked by actual experience in the air, we now know much better than, say two years ago, the fundamental conditions which must be met by the carbureter for the aeronautical engine. The present solution can hardly be considered as final, however, and we may fairly admit that the whole problem of carburetion, including the manifold supply of the carburetted mixture to a multi-cylinder engine, should, as soon as may be, receive a thorough and fundamental re-study in the light of the information to be drawn from the experience of the past three or four years.

New Ignition Device Required

Another problem which we should view as outstanding is that of ignition. It is true that ignition, as now realized with the best equipment, seems to be fairly reliable and effective. But the whole program is open to the objection of requiring an entire electric powerplant of a highly specialized type, together with electric conductors and the spark-plug for producing the spark between the discharge points within the cylinder. This ensemble, comprising electric generator or magneto, electric cable, distributor for sending the spark with proper timing to the various cylinders, and spark-plug with discharge points within the cylinder, represents a very complicated and highly specialized device for producing the initial ignition within the body of compressed fuel mixture. In its present state it is a marvel of scientific and technical development, and it does its work; but it is complicated and subject to many possible modes of derangement, and, as we all know, has been and is still the seat of some of the most serious of the engine difficulties to which the powerplant as a whole is subject.

I have never been able to persuade myself that this exceedingly complicated and specialized auxiliary equipment was to be the final solution of the problem of producing ignition in an internal combustion engine. If we can anticipate the explosion engine of the year 1968, assuming that our grandchildren are still dependent on hydrocarbon fuels at that date (and furthermore that they are still available), it would seem as though some more direct and simple mode of initiating the combustion in the cylinders would have been found. Still, otherwise, we may say that on the law of probability the chances are overwhelmingly against our having at the present moment developed the very best method of ignition. The laws of physics and chemistry, by a probability which almost reaches certainty, contain some potential combination of factors which will permit of eliminating much of the complexity and delicacy of adjustment which is so characteristic a feature of the present mode.

It is perhaps proper to add here that studies in this direction have already been made, and with results which offer promise of interesting developments in the future. The path of perfection is likely to be not a short one, however, and we can see no prospect of any development in the tomorrow of progress likely to displace electric ignition. There must, however, be some better way, and if not tomorrow, then some other morrow should see it made available for use.

The problem of ignition is, then, one which is distinctly outstanding, one which by its importance merits the most careful study, and one which at least offers reasonable ground for hope of a successful and relatively simple substitute for the present mode.

Maintenance of Power at Altitude

We come now to a problem of the very highest present and future importance, that of maintaining the power of the engine at high altitude.

The situation as it develops in the case of an airplane mounting to higher and higher levels in the atmosphere is readily appreciated with a moment's thought.

The power of the engine arises from the combustion of vaporized hydrocarbon fuel. The power per cycle for a given cylinder will, therefore, to a first approximation, and assuming a sensibly constant efficiency of thermodynamic transformation, vary directly with the weight of the fuel which can be burned per cycle. But this in turn depends upon, and is conditioned by, the amount of oxygen which can be drawn into the cylinder per intake stroke of the cycle. But the oxygen is brought in as one of the constituents of the atmosphere, and hence the amount of oxygen available per intake stroke will depend upon, and be directly proportioned to, the amount of air which can be drawn in. But in terms of volume, just a cylinder full or more exactly, just the volume represented by the piston displacement in moving from one end of the stroke to the other, can be brought in. Hence we may at least depend on what we may term a cylinder volume of air, no matter where we are. But just here arises the trouble. The actual weight of air depends conjointly on the volume and on the density, and unfortunately for the aeronautical engine at least, the density of the atmosphere decreases steadily with altitude, so that at 15,000 ft., for example, the density is only about 60 per cent of the normal density at the earth's surface. It is clear, then, that an aeronautical engine, other things equal, will draw in, per intake stroke, only about 60 per cent of the weight of air at this altitude as compared with the indraft at the earth's surface. Hence it will be able to burn only 60 per cent of the fuel, and with equal efficiency will develop only 60 per cent of the power.

But here we must stop for a moment and inquire as to the effect of such reduction of power on the speed of the airplane. We know that, other things equal, the resistance of an airplane to propulsion through the air at uniform speed varies directly with the density of the medium. Hence, with the same speed as when near the surface of the earth and at the same altitude and angle of attack, the airplane at 15,000 ft. elevation would experience only 60 per cent of the resistance, require 60 per cent of the thrust, and, at constant revolutions of the propeller, 60 per cent of the power from the engine.

It appears, therefore, at first sight as though we had lost nothing in speed by the reduction of the power of the engine. If the latter has been reduced to 60 per cent of its amount at low levels, so has the resistance and power required, so that the speed realized should remain the same.

Such would indeed be the case if this were all; but unfortunately other considerations enter, and the simple relation of uniform speed at varying altitudes cannot be realized without compensating features.

Thus, if at a constant speed and constant angle of attack for the wings the resistance to propulsion is only 60 per cent as great at the altitude of 15,000 ft. as on the ground, it is unfortunately the same for the lifting force developed by the wings. This also is only 60 per cent as great, while the weight of the machine remains sensibly constant at all altitudes. Let us grasp this fact clearly, that while, at constant speed and altitude of flight, the resistance, the lift, and all other aerodynamic forces involved vary directly with the density of the air and decrease with the altitude, the weight of the machine and the lift necessary for support remain sensibly unchanged. Hence at the same altitude of flight, and under the same speed, the lifting force will no longer support the plane and unless something is done it would be unable to maintain horizontal flight at such altitude.

Two courses are, then, open for consideration, as follows:—

1. We may seek to increase the speed until at such increased value the lift will equal the weight of the plane. Under the conditions assumed this would involve an increase of speed of about 30 per cent, thus increasing the resistance to propulsion by nearly 70 per cent, or bringing it back to its value at low altitude. But this resistance overcome at the increased speed would mean an increase in the required horsepower of 30 per cent as compared with that normally developed at low level, while with the actual indraft of air, and, even allowing for the increased speed, only some 78 per cent of this, or 60 per cent of the needful amount, would be developed. Hence no such speed could be realized, and the support of the unvarying weight in the rarefied air cannot be realized in this manner, and must be sought otherwise.

2. Instead of seeking for the necessary lift by increased speed, we may seek it by changing the angle of attack—by changing the flying attitude of the plane so that at the same speed, for example, the lifting force will be greatly increased. In this manner the needful lifting force may indeed be realized. But unfortunately with the increase in lifting force will come also an increase in head resistance, not proportionally, but still a definite increase. This will mean that the actual resistance at, say, 15,000 ft. elevation will be greater than 60 per cent of that at low elevation, and with 60 per cent of the power available per cycle, the original number of revolutions cannot be maintained, and a reduction in speed will result. With this reduction in speed will come a further loss in lifting effect and need for a further change in the angle of attack, with increased head resistance, until finally, at some reduced speed, a condition will be found where the needful support for the weight of plane may be realized and the resistance to propulsion can be met by the thrust or pull developed at the propeller. In these conditions horizontal flight again becomes possible, but at a speed somewhat below that corresponding to low altitude conditions.

In addition, we must reckon on a diminished efficiency of the engine with decreased power, and with the probability of a loss in propeller efficiency with the resultant change in speed. Thus, if an engine is primarily designed to work at its best efficiency and under its best conditions at or near full atmospheric pressure and density, it will not work with equally good efficiency at high altitudes in rarefied air and when developing only about one-half the power for which it is primarily designed.

In brief, at an altitude of, say, 15,000 ft., the plane must fly at a less advantageous angle of attack but with more resistance, and the engine will be able to burn only about 60 per cent as much fuel, and will transform the resulting heat less effectively than when at low altitudes. Therefore, the power developed will be less than 60 per cent, and insufficient to maintain the same speed; and with diminishing speed there may be further loss of efficiency in the propeller and a further loss of speed, until finally matters become adjusted at some value usually definitely and sometimes considerably less than that corresponding to low-level conditions.

As an over-all practical result, an airplane normally loses horizontal speed as it ascends to higher altitudes.

Confronted with this fundamental fact, what is to be done? Such loss of speed, especially in a military sense, is or may become very serious, and one of the large and definitely outstanding problems in aeronautical engineering at the present time centers about the possible ways and means of meeting this condition.

The obvious proximate solution is to avoid, so far as may be, the decrease in the amount of air handled per intake stroke of the piston as the plane ascends to higher and higher altitudes.

Broadly, two courses are open. First, we may definitely and frankly design the plane and engine for a certain desired performance at a given altitude, say 15,000 or 20,000 ft. This is a straightforward problem in aeronautical engineering. Given the desired schedule of operation and the altitude, we can determine the resistance to be overcome and the horsepower required, and can design the engine accordingly. In such case the volume of the cylinders will be suited to the rarefied air in which the engine is to work, and all proportions and details will be worked out on this basis.

It will be obvious that such an engine will have much too large a piston displacement volume when at low altitude—that is, it will be over-size and over-powered relative to the plane. In fact, operation near or on the ground under the same adjustments as at altitude would be quite out of the question. Means must therefore be provided for reproducing, when on the ground or at low altitudes, substantially the operating conditions at high altitudes and low air density—that is, the conditions for which the engine was designed. This may be most conveniently done by throttling down the air intake, so that while air at or near full sea level density may surround the engine, it will be reduced in pressure at the intake throttle to such a degree that the amount actually taken into the cylinder will only equal that which would normally enter, without throttling, at high altitude.

On the other hand, we may definitely design the engine for operation at or near sea level and with size of cylinders and all proportions and adjustments worked out accordingly, and then by a supplementary device endeavor to maintain or to nearly maintain such conditions within the engine itself, even if it is at high altitude and surrounded by air of a lower density.

This solution calls for some supplementary form of compressor or equivalent device which shall operate on the rarefied air as a first stage, and raise it from the

low pressure characteristic of the altitude up to or nearly to normal low altitude pressure and density.

Each of these alternatives represents a perfectly possible solution. Each has its special advantages and disadvantages. Each has its advocates as a solution of this important problem.

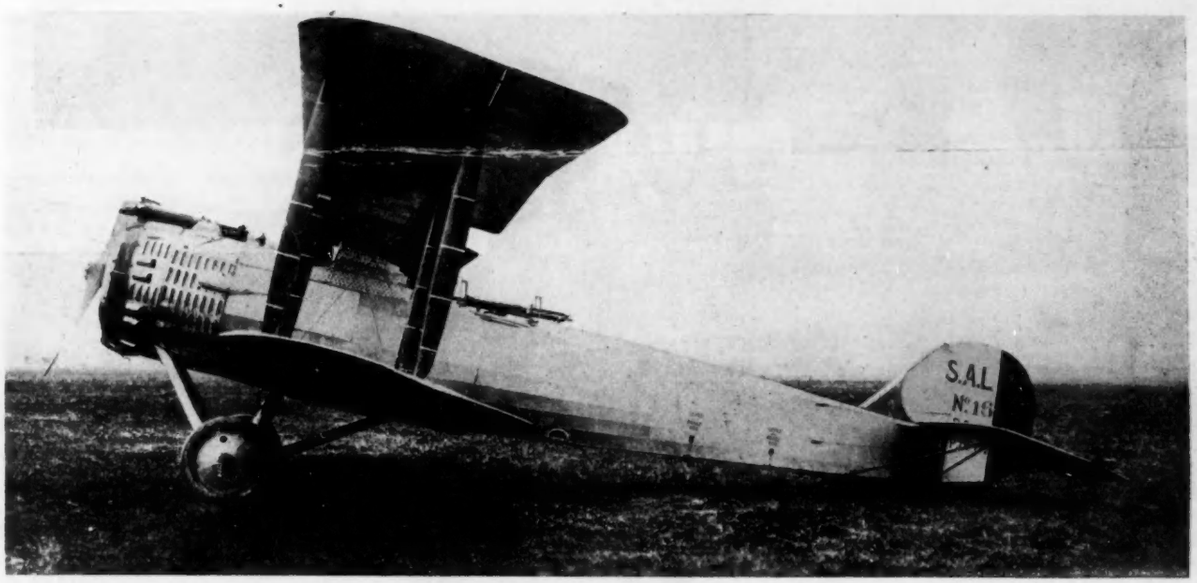
The first solution is the simpler of the two, since it involves no special or additional device to compress the air.

It does, however, mean extra weight in the engine, which is always there, and which will reduce correspondingly the net carrying capacity of the plane.

On the other hand, the compressing device of the second solution is not easy to realize satisfactorily, and it also involves extra weight, though presumably less than in the case of the first solution. Again, its operation as a separate or independent unit for realizing a preliminary compression of the air is less efficient than to do the whole compression in the engine itself and by the engine piston, as in the first solution. Only extended and careful trial will presumably be able finally to decide which is on the whole the better solution of the two.

The reserve necessary with regard to military matters makes it unwise to attempt to give any account on this occasion of just where the matter stands with regard to this problem, but it will at least be safe to note that it is a problem which is attracting much attention and study on the part of the Allied Governments, and that much valuable information is being developed, and on which we may hope that some satisfactory solution may be based.

(To be continued)



FRENCH TYPE OF BIPLANE, THE SALMSON

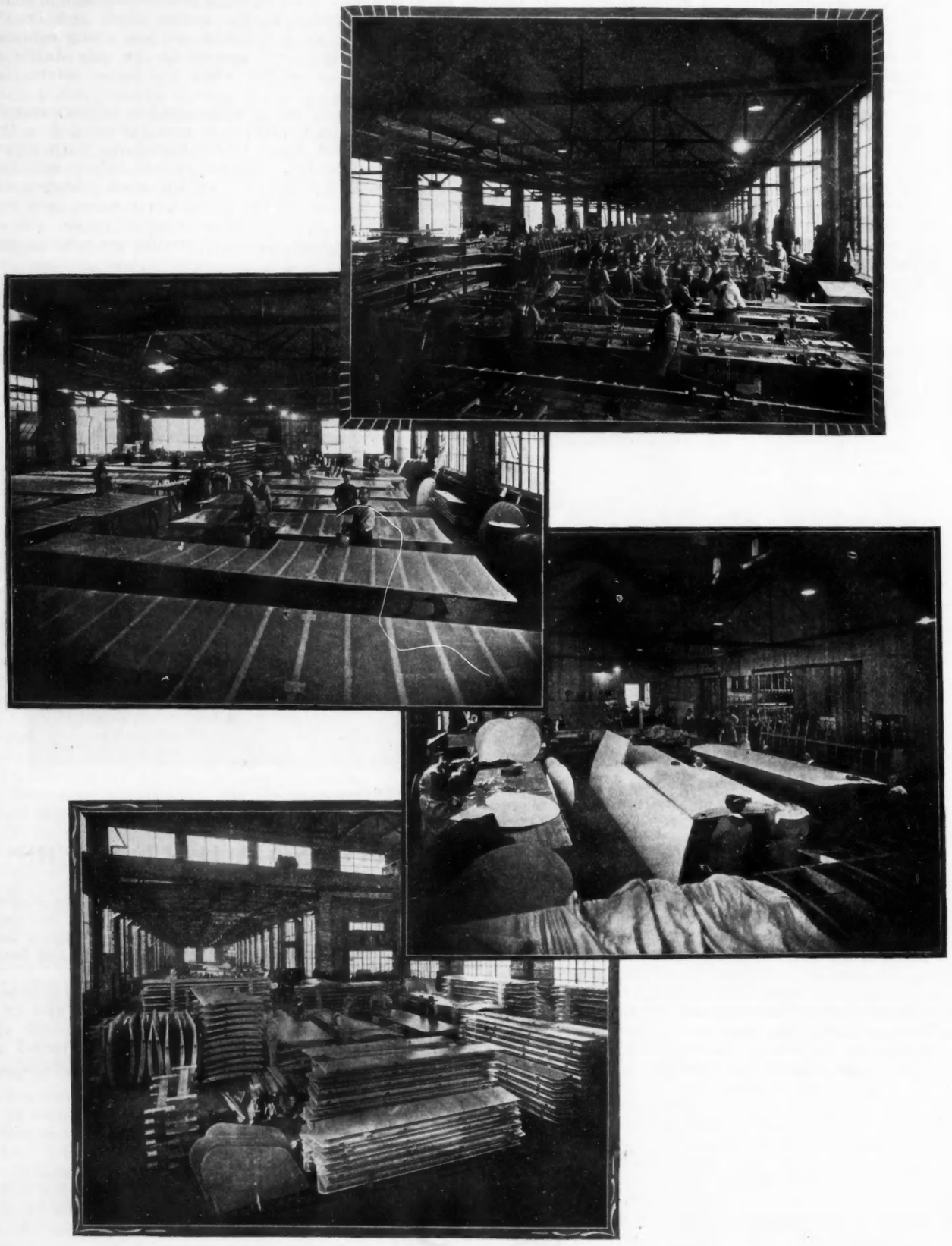
WASHINGTON TO NEW YORK IN TWO AND A HALF HOURS

AIRPLANE mail was carried from Washington to New York July 10 in 2½ hours, including the stop at Philadelphia.

The average rate of speed for the entire trip was over 90 m.p.h. and that between Philadelphia and New York was 108 m.p.h. During the month of June the Airplane Mail Service made the remarkable record of falling below 100 per cent only six times.

Increasing familiarity of the fliers with conditions attending the flights has resulted in a considerable shortening of the average time. The direction of the compass is compared with the chart every 10 minutes during the flight and at each of the larger towns on the route. In this way the route through the air has been accurately charted.

Lieutenant C. P. Culver has come within three minutes of the aerial mail record between Philadelphia and Belmont Field, carrying a passenger and 180 pounds of mail in a heavy rain and thunderstorm. The record is 42 minutes, and he flew the ninety miles in 45 minutes.



MANUFACTURE OF AIRPLANE WINGS IN A CANADIAN FACTORY

British Aircraft Supply

THE following paragraphs are extracted from the report for the year 1917 of the War Cabinet of Great Britain relating to supply of aircraft. They are taken from the pamphlet* reprinted by the Smithsonian Institution, with the permission of Lord Reading, the British Ambassador.

The description given of the difficulties in the way of obtaining a supply of aircraft is so accurate and is so general in its application to all countries that it is believed it should be given as wide a circulation as possible in America. Its application to the American aircraft situation is evident if we remember that Great Britain has been at war since August, 1914, and that every resource of the country, famous for generations as the center of mechanical developments, has been applied to the problem of the production of aircraft. This enables us to appreciate more clearly the progress made by the United States in 1917-18.

Danger in Publishing Facts

"In endeavoring to describe the measures taken to meet the aircraft needs of the Navy and Army, we are at once confronted by the fact that the information desired by the country is precisely the information desired by the enemy. What the country wants to know is what has been the expansion in our Air Services; whether we have met and are meeting all the demands of the Navy and of the Army, both for replacement of obsolete machines by the most modern types and for the increase of our fighting strength in the air; what proportion of the national resources in men, material and factories is being devoted to aviation; what the expansion is likely to be in the future. These are precisely the facts which we should like to know with regard to the German air service, and for that reason it would be inadmissible for us to supply Germany with corresponding information about ourselves by publishing a statement on the subject.

"It can be said that the expansion of our Air Services is keeping pace generally with the growing needs of the Navy and the Army.

"The brilliant part played by the Royal Flying Corps and the Royal Naval Air Service in the battles of the Somme, Vimy, Messines and Ypres has been described by the Commander-in-Chief, who has also borne frequent testimony to the inestimable value of the work performed daily and nightly by the two air services. It is fair to say that not even the well-known superiority of our airmen over those of the enemy would have enabled them to earn the Commander-in-Chief's praise in so unstinted a measure unless they had been supplied with satisfactory machines and equipment from home. It is rather the fashion to criticise the quality of our machines. Most of the critics, however, are ignorant of the technical and manufacturing difficulties which have to be overcome in order to keep up a constant and increasing supply of the most up-to-date machines. Not only are the technical difficulties and the resultant research and experimental work formidable in themselves, but the task of building up in war time, without seriously affecting the requirements of other services, a new industry of a most highly skilled character, necessarily puts a heavy strain upon the organizing and manufacturing ability of the country. The growing realization of the increasing importance of aviation as an artificer of victory has recently been reflected in the concession of first priority to labor and materials required for aircraft production.

"The nature of the duties performed by the Royal Naval Air Service, both in conjunction with the fleet and from naval bases, makes secrecy essential to success. It is, unfortunately, inevitable, therefore, that the public should remain in the dark on this subject; but the Germans, who in this matter are perhaps the best judges, have good reason to know and to regret the great and growing activities of the Royal Naval Air Service. All that has been said regarding the difficulties of supplying the requirements of the Air Forces operating over the land applies equally to the supply of those which operate over the sea. In both cases difficulties are being overcome and the outlook is improving.

Development Necessarily Slow

"The science of aeronautics is in a state of constant and rapid development; improvements in engines, airplanes and their numerous accessories are constantly being worked out. But the interval between the discovery of an improvement and its introduction into the service is, owing to technical considerations, very much longer than is commonly supposed. Experience shows that, as a rule, from the date of the conception and design of an aero-engine to the delivery of the first engine in series by the manufacturer, more than a year elapses; the corresponding period for an airplane is about one-half as long. Consequently, plans have to be laid for a long period ahead, and these plans are liable to be upset by many uncertain factors. The hopes based upon the promising results given by the first experimental engines of a new design are frequently disappointed owing to difficulties of bulk manufacture or to defects developed only after long trial in the air; new types of airplanes favorably reported on when first tried are found on longer experience not to give complete satisfaction, and yet it is impossible, if we are to keep ahead in the keen struggle for aerial superiority, to wait for full experience before placing orders. Risks must be run, and new types must be adopted at the earliest moment consistent with reasonable assurance that they will constitute a substantial improvement on what is already in use. Orders must be placed, moreover, for considerable numbers and for delivery over many months, as the large output required for our present flying services can only be obtained by bulk orders permitting a high degree of subdivision of work.

"The next step in the problem is the balancing of the engine and the airplane programs. Owing to the much longer period required for the production of engines than of airplanes, orders for the former must be placed for relatively long periods ahead, before it is known what types of airplanes will be required when the engines become available.

"The problem is complicated by the fact that manufacture and delivery rarely if ever proceed in accordance with anticipation. The output of a particular type may be delayed for weeks or even months owing to some technical difficulty of manufacture. Moreover, as replacement of losses and expansion are proceeding simul-

*Smithsonian Miscellaneous Collection, Vol. 69, No. 7

MANUFACTURE OF AIRPLANE BODIES IN A CANADIAN FACTORY

taneously in the flying services, and the rate of wastage in different types of engines and of airplanes varies considerably according to circumstances, it is impossible to forecast with accuracy what engines will be available for the equipment of new types of airplanes after wastage has been made good. Nor is it possible to any great extent to adjust the program by modifying orders once placed without disorganizing supply. The problem does not end here. Whenever a new type is introduced provision must be made for accumulating a sufficient "head" of spare engines, spare airplanes and spare parts of innumerable kinds, to keep the squadron to be equipped with that type in a condition to make good the day-to-day wastage and carry out the constant repairs required.

"Such being the nature of the problem, it is satisfactory to be able to record that during the year 1917 not only was the number of squadrons of aircraft on the various fronts increased in a notable degree, but there was a complete replacement of machines and engines of the older types. The very great increase in output which is being obtained has placed a considerable strain on the workers in the aircraft and aero-engine factories of the country, a strain which is being met on the whole in a satisfactory manner.

"The difficulties in connection with production are aggravated by the competing claims of many different types of aero-engines. Standardization is the ideal but it is obviously difficult of attainment having in view the importance of not losing time in production and at the same time of keeping abreast with the very latest developments necessitated by the need for constant increase of horsepower and higher performance. The Air Council is most keenly impressed with the need for concentration on a few approved engines, and has the whole question of the reduction of numbers of types under constant and careful consideration.

Maintaining Interest of the Workers

"Attention has been drawn, on more than one occasion, by manufacturers to the importance of maintaining the interest of workers in aircraft factories in the highly important but generally monotonous work on which they are employed. Engaged, as they frequently are, on the production by a repetition process of some small part of an airplane, these men and women find it difficult to realize that they are contributing effectively to one of our most valuable instruments of warfare. It was accordingly arranged that Captain Ewart, R. F. A., well known as a writer by the name of 'Boyd Cable,' should visit various squadrons at the front and gather materials and photographs for lectures concerning the exploits performed with various types of aircraft, for delivery to the workpeople engaged on the manufacture of those particular types. Captain Ewart delivered several series of lectures which, judging from the reports received from the factories concerned, proved a very great success."

HOW THE RED CROSS SAVES GASOLINE

GASOLINE consumption in France, at least on American Red Cross ambulances, is measured by blocks to the liter rather than miles to the gallon. Gasoline, or "essence," as it is called, is not at all easy to get in the war zone, is, in fact, almost impossible to buy for cash. Fortunately, the gasoline stations maintained by the French and American armies cooperate with the American Red Cross Motor Service, and allow ambulances and trucks to obtain limited quantities of gasoline on "carnet" or triplicate orders supplied to Red Cross drivers. Any gasoline obtained from a French station, however, is merely borrowed, and the Red Cross must return it, liter for liter, from stocks reaching it at the various ports. The officials orders filled from American Army stores are redeemed in cash. The French, however, will not part with their gasoline for money.

With gasoline as well as equipment so precious, the Red Cross has instituted unusual gasoline-saving measures govern to its entire fleet of 634 ambulances, trucks and other gas vehicles. Carbureter adjustments receive unremitting attention. No car is allowed to continue to run with leaking valves or any other defect which will lower its "blockage" per quart, or waste oil. No chauffeur who is not expert in getting maximum "blockage" remains long at the wheel.

Every opportunity for joy riding is eliminated. No car leaves the garage even for a trip of four blocks until the odometer reading is taken carefully and gasoline in the tank or in reserve cans is measured accurately. The driver starts out with a trip card registering all these facts, and new readings are taken on his return to the garage or on his arrival at the next Red Cross transportation station. If his odometer shows that he has deviated from the shortest path between the garage and his objective, or if his time indicates that he has been delayed, he is called upon for an explanation. A doubtful excuse brings a sharp warning; a second offense puts him on the "wash rack," to wash dirty cars for several days. As all Red Cross drivers are militarized he has to take his medicine. A third offense may send him to the Provost Marshal of the American Army in Paris as a military offender. Various punishments are meted out, but the most feared of all is said to be an order that the man be separated from the Red Cross and sent back to America in disgrace.

Nomography in Engine Design

By F. Leigh Martineau (*Member of the Society*) *Illustrated with* Charts

THE word "nomography" means literally "the art of drawing up laws in proper form."

The "laws" of the engineer are expressed as formulas with different numbers of variables, and the "nomogram" of the engineer is a diagram giving graphically the solution of a formula in such a form that all functions of the variables can be found by reference to the diagram alone without further construction or calculation.

As a general rule nomograms can be easily constructed to give the solution of all formulas, and they are without doubt a device of great importance to the engineer of today, by assisting in the calculations necessary with more rapidity than a slide rule and without the possibility of the introduction of errors which exists in its use. It may be said that nomography can be an aid to efficiency in the office and factory.

It was originally the intention of the authors to deal with this subject both theoretically and practically, but in preparing the paper it became obvious that such a course would produce a paper of inordinate length, and it was therefore decided to deal only with the practical side of the question.

The subject of the paper was first introduced by M. d'Ocagne, Ingénieur en chef des Ponts et Chaussées, Professeur à l'Ecole polytechnique in Paris, in or about the year 1884, and many works on the subject have been produced by him since.

The first notice of the subject in England appears to have been an article in the Magazine of the Royal Artillery Institution in 1910 from the pen of Capt. (now Lieut.-Col.) R. K. Hezlet, R.A.

"Nomography or the graphic representation of formulas," by the same author, appeared in 1913.

Apart from Colonel Hezlet's booklet and a few articles in the technical press, very scant attention seems to have been paid to this extremely useful method of dealing with all the hundred and one calculations necessary daily in the ordinary routine work of an engineer.

The authors have found the diagrams got out on this system to be of immense benefit and real labor savers, and it is their hope that the information given will be of the same help to others.

Those who are well versed in the methods dealt with will perhaps forgive the authors for treating the subject in the simplest manner, and for eliminating where possible all technical and mathematical terms. This has been done in order that the information may be of use to those who are without great mathematical experience. It is hoped that even so this paper may lead to the study of the more complete works on the subject already mentioned.

Two Variable Formulas

It is usual to represent two variable formulas by a graph in cartesian coordinates, the abscissas representing the values of one variable and the ordinates the values of the other. In such a case a definite curve is formed, see Fig. 1, in which the abscissa a and the ordinate b of any point on the curve represent corresponding values of the variables.

In this instance

$$b = 1/a \qquad (1)$$

that is, b is the reciprocal of a.

Here the intervening values have to be read by the intersection of the two lines representing abscissa and ordinate, and as a consequence interpolation is difficult.

This type of diagram is called by Colonel Hezlet an "intersection" diagram.

The corresponding nomogram becomes one single line with two scales, one reading on each side.

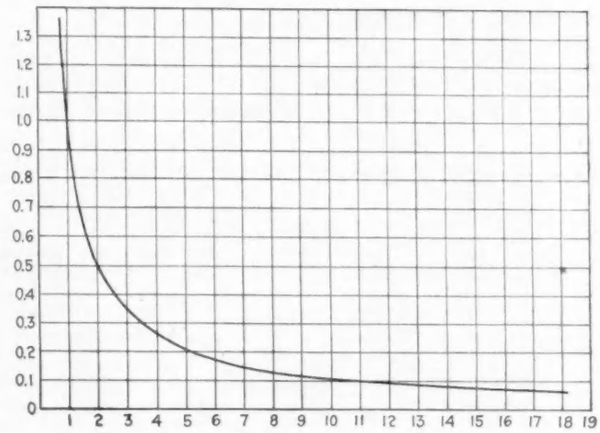


Fig. 1—Graph of Numbers and Reciprocals

Two different nomograms are given in Fig. 2 to show this and are both converted from Fig. 1.

In each instance a is the right hand scale, that is, the number, and b is the left hand scale, that is, the reciprocal.

In (I) the number scale is regular and the reciprocal scale varied to suit it, whilst in (II) both scales are logarithmic scales, the one reversed on the other.

It will be noticed that in this instance interpolation for intermediate values is quite easy, and further that the diagram with the logarithmic scale renders this more simple than the regular scale.

Three Variable Formulas

When a graph is made to represent three variables in cartesian coordinates, it is necessary that two should be indicated by abscissa and ordinate respectively, and that a series of curves should be drawn representing definite known values of the third variable.

The diagram given in Fig. 3 shows such a graph, in which the ordinates indicate the fuel used in lb. per hp. per hr. by an engine and the abscissas the thermal efficiency per cent, whilst a series of curves are drawn

This paper was recently presented before the Institution of Automobile Engineers, London. The author was assisted by A. Marshall Arter in preparing this paper.

representing known values of fuel in British thermal units per pound.

If, as an example, it is desired to find the efficiency of an engine using fuel of value 17,700 B.t.u. per lb. and consuming 0.54 lb. per hp. per hr., then it is necessary to interpolate the value of the fuel and afterwards refer to the base line for the efficiency. This operation is extremely difficult in a diagram of this type, and one likely to lead to error.

When, however, this "intersection" diagram is changed to a nomogram or "alinement" diagram, all these difficulties disappear and the reading is rendered much more accurate.

Fig. 4 shows such a nomogram, from which by the

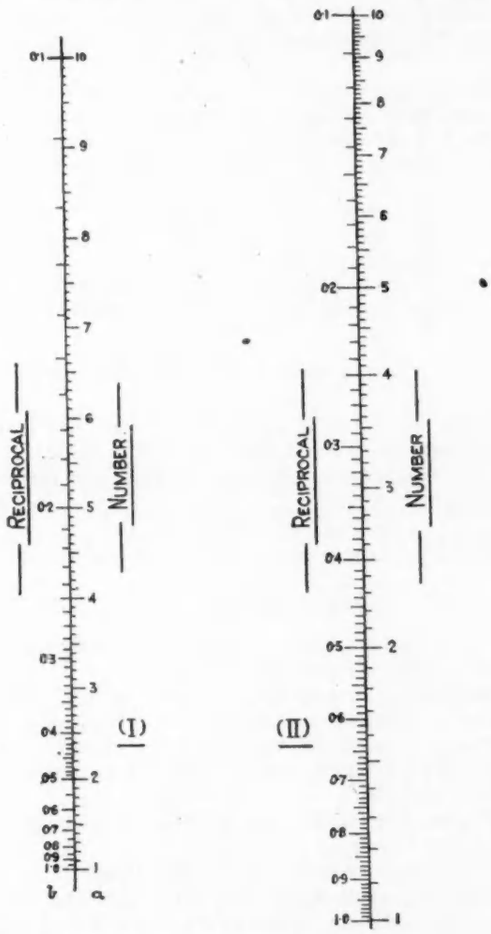


FIG. 2—SCALES OF NUMBERS AND RECIPROCALS

simple drawing of one straight line, the thermal efficiency of any engine can be at once obtained. The diagram can obviously be used for either indicated or brake efficiency as may be desired.

It will be noticed that it has been possible to make this diagram over a much larger range than the other, so large in fact as to make it include almost all usual fuel values and all reasonable consumptions.

A further reference to Fig. 3 will show that should it be required to read this diagram in metric measurements, it can be arranged with the ordinate scale graduated also in grams of fuel per hp. per hr., but the curves drawn across the diagram to represent fuel values will not then be read in round numbers for calories per kilogram of

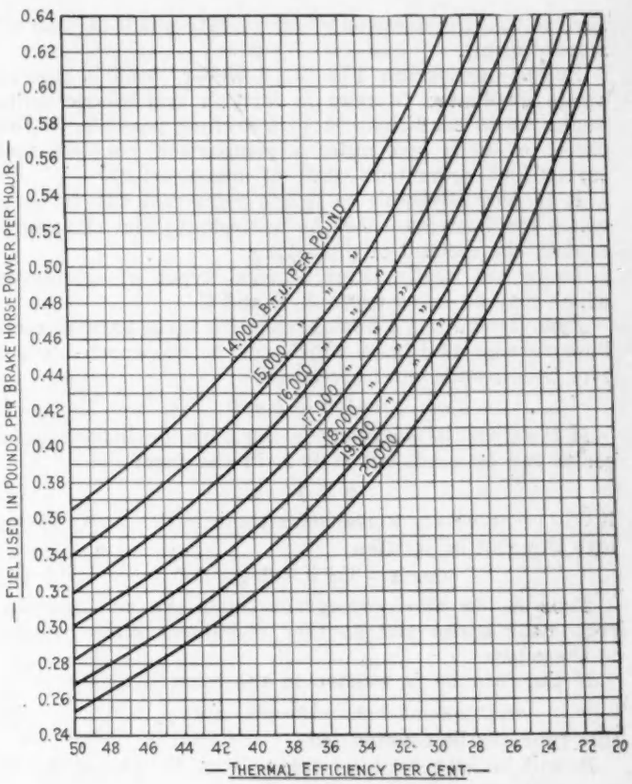


FIG. 3—THERMAL EFFICIENCY "INTERSECTION" DIAGRAM

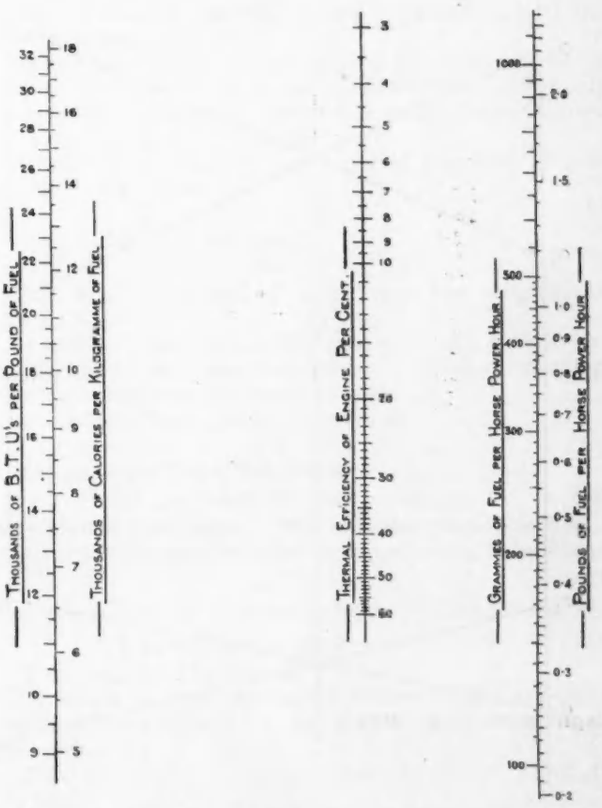

— THOUSANDS OF B.T.U.'S PER POUND OF FUEL —
— THOUSANDS OF CALORIES PER KILOGRAMME OF FUEL —
— THERMAL EFFICIENCY OF ENGINE PER CENT. —
— GRAMMES OF FUEL PER HORSE POWER HOUR —
— POUNDS OF FUEL PER HORSE POWER HOUR —

FIG. 4—THERMAL EFFICIENCY "ALINEMENT" DIAGRAM

fuel, so that the question of interpolation will become still more difficult.

In the nomogram Fig. 4, however, both scales are easily graduated to read in British and metric units; under these conditions it is therefore possible to read either or both and make a comparison between tests carried out under both units of measurement.

It is now advisable to define somewhat the formulas which can be represented by nomograms and afterwards explain the method of procedure.

There are really three general types of nomogram which may be called types A, B and C.

Type A—This is a nomogram with three parallel rectilinear scales as Fig. 4 which can be constructed whenever the formula can be written:

$$a + b + c = 0 \qquad (2)$$

If the formula is already in this form ordinary regular scales can be used, but if it is in the form

$$a \times b = c \qquad (3)$$

it will be necessary to use logarithmic scales, as by taking logs this can be written:

$$\log a + \log b - \log c = 0 \qquad (4)$$

Type B—In this nomogram there are two paralled rectilinear scales and another rectilinear scale inclined to these two.

If the formula is written in the form

$$a + bc = 0 \qquad (5)$$

this type can be constructed.

It will be seen that by taking logs this type can be generally converted into Type A.

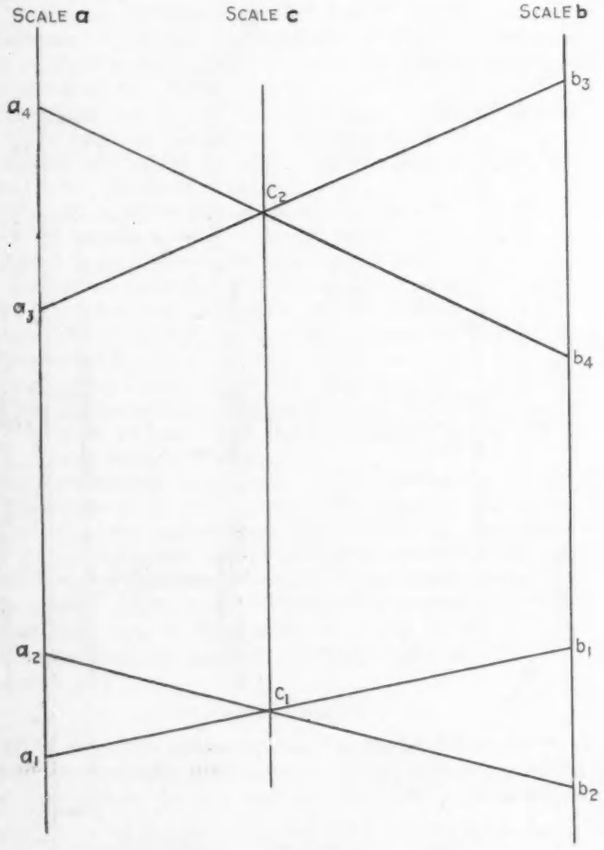


FIG. 5—METHOD OF PLOTTING THE DIAGRAM

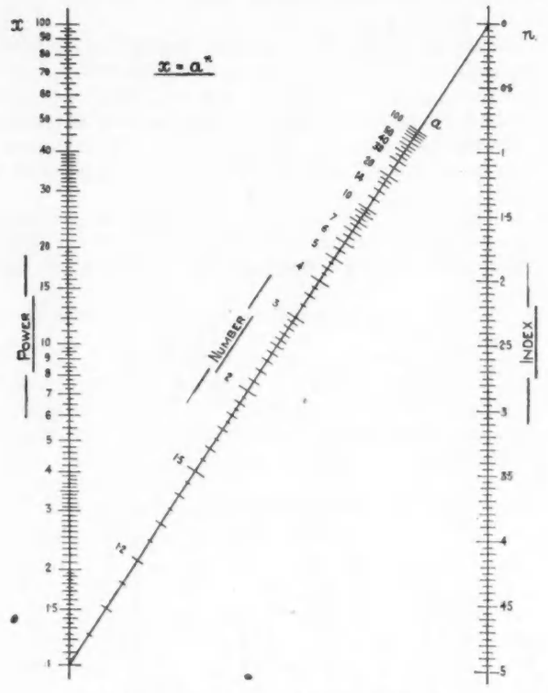


FIG. 6—POWERS AND ROOTS OF NUMBERS

Type C—In this nomogram there are two parallel rectilinear scales and one curvilinear scale.

This type can be constructed when the formula can be written:

$$ac_1 \pm bc_2 \pm c = 0 \qquad (6)$$

where c_1, c_2, and c are functions of the third variable c.

METHOD OF PLOTTING DIAGRAMS

The plotting of these diagrams is really quite a simple matter after a little practice.

Although the relative positions of the lines and the scales to be used are capable of being calculated, it involves a complete knowledge of the theory on which the diagrams are based, and it is generally unnecessary to go to this trouble.

The method which can be used in most cases may be described briefly as follows:

In the first instance, settle the range it is desired to indicate on each scale, and after drawing two parallel lines, say some six inches apart on a piece of paper, mark roughly thereon a few points of the scale suggested. This can be done with the scale of a slide rule as a guide, if a logarithmic scale is to be used, or with an ordinary scale in the case of a regular scale.

Assume values of the first two variables; that is, those scaled on the two outer lines, and obtain a value for the third variable by calculation; with this value and a second value for the first variable obtain a second value of the second variable; to fulfil the conditions of the diagram these values lie on two straight lines, joining points on the two outer parallel lines and crossing at the common value on the central line. One point on the central line and its value is therefore determined. Repeat this process at the other end of the diagram, and the result will be that two points will be fixed giving the position of the central line and its scale; this line can therefore be drawn and the scale added to it.

Reference to Fig. 5 will make this quite clear; in this, the line a is graduated to suit the first variable, and the line b to suit the second variable, these being the two outer scales. With values a_1 and b_1 a value c_1 is determined, then with values a_2 and c_1 the value b_2 is found; these can then be plotted on the scales and will be represented by two straight lines $a_1\ c_1\ b_1$ and $a_2\ c_1\ b_2$ which cross at the point c_1.

Further values are then obtained such as $a_3\ c_2\ b_3$, and $a_4\ c_2\ b_4$, and these are drawn in as in the diagram.

Logarithmic Scales Generally Employed

As a general rule it is necessary to use logarithmic scales. To facilitate the laying out of these the authors have devised a simple adjunct to the slide rule which enables scales to be quickly and accurately laid off on paper.*

Generally it has been found desirable to make a rough diagram to ascertain that all the proportions are correct and that the scales read in the right direction, and afterwards make a finished one from the data thus determined.

SIMPLE EXAMPLES

As examples of the uses to which these diagrams can be put the following may be interesting.

The relation between the roots and powers of numbers is represented in Fig. 6.

The formula in this case is

$$x = a^n \tag{7}$$

or taking logs

$$\log x - n \log a = 0 \tag{8}$$

This is type B nomogram.

It will be noticed that by means of this diagram powers and roots with fractional indices can be dealt with as easily as those with ordinary whole number indices.

*A full description of this device is included in the original paper.

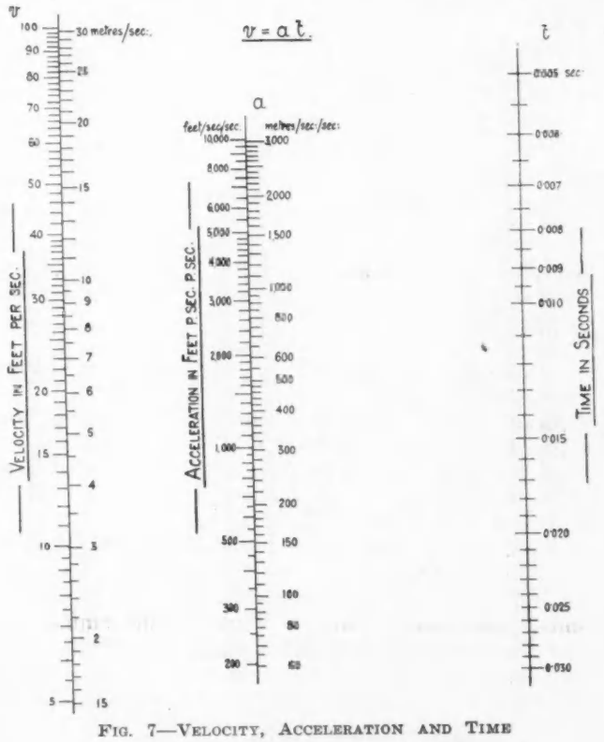


FIG. 7—VELOCITY, ACCELERATION AND TIME

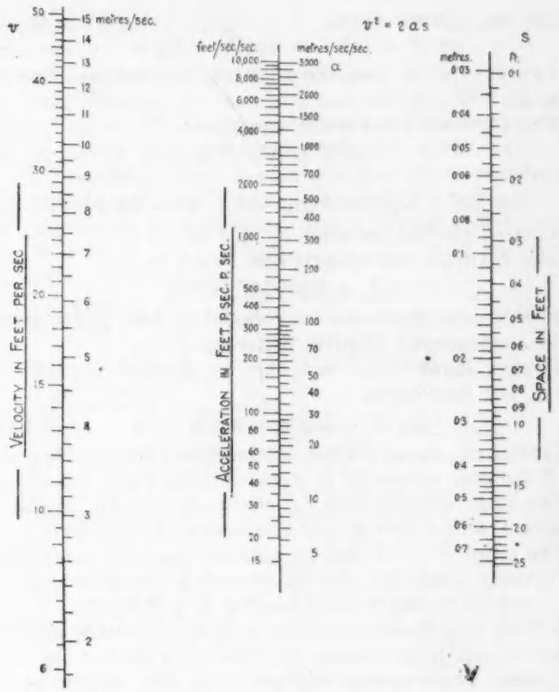


FIG. 8—VELOCITY, ACCELERATION AND SPACE

In this figure a straight line joining the index on the right-hand scale, across the number scale in the center, gives the power of the number on the left-hand scale. Obviously if the root of a number is desired, the line will join the number in the left-hand scale to the index in the right-hand, and will cross the center scale at the required root.

Incidentally it will be noticed that this diagram shows that any number to the power of zero is one, as the only straight line crossing all numerical values joins the zero index to one on the power line.

Amongst the ordinary fundamental formulas in general use is the formula

$$v = a\,t \tag{9}$$

Taking logs this becomes

$$\log v - \log a - \log t = 0 \tag{10}$$

This is a nomogram of type A and has been plotted in Fig. 7.

It will be noted that in this case also both British and metric units have been employed, and direct comparisons or conversions are therefore possible.

A further fundamental formula is

$$v^2 = 2\,a\,s \tag{11}$$

Taking logarithms this becomes

$$2 \log v - \log 2 - \log a - \log s = 0 \tag{12}$$

or a type A nomogram. This has been plotted in Fig. 8.

Amongst the fundamental formulas is also to be found:

$$s = a\,t^2/2 \tag{13}$$

This expressed as logarithms with s in inches becomes

$$\log s - \log 6 - \log a - 2 \log t = 0 \tag{14}$$

This is plotted in Fig. 9.

This will be found useful for determining the average acceleration produced by valve cams with constant acceleration.

The force due to acceleration is found from the formula

$$F = Wa/g \tag{15}$$

or in logarithmic form

$$\log F + \log g - \log W - \log a = 0 \qquad (16)$$

Again type *A* and the plotting become as shown in Fig. 10.

The formula for kinetic energy is

$$KE = W v^2/2\,g \qquad (17)$$

or

$$\log KE + \log 2 + \log g - \log W - 2 \log v = 0 \qquad (18)$$

This as plotted becomes as in Fig. 11.

The formula for centrifugal force is

$$CF = 0.000343\,W\,r\,N^2 \qquad (19)$$

In this case there are four variables and the procedure is in consequence slightly different.

Taking logarithms this can be divided up into two parts, the first being

$$\log W + \log r - \log X = 0 \qquad (20)$$

This is of course a type *A* nomogram giving the values of X for any values of W and r. (See Fig. 12.)

The ungraduated line, called the reference line in the diagram, is the line giving the result of this formula.

The point on this line so obtained is then used as one variable in a second part expressed by the formula

$$\log CF - \log 0.000343 - \log X - 2 \log N = 0 \qquad (21)$$

and from this is obtained the centrifugal force produced at any speed of revolution by drawing a second line from the speed scale across the point on the reference line already found to the centrifugal force line.

Conversely, if, for example, in a governor design it is desired to find the weight and radius to produce a known centrifugal force at a predetermined speed, by joining

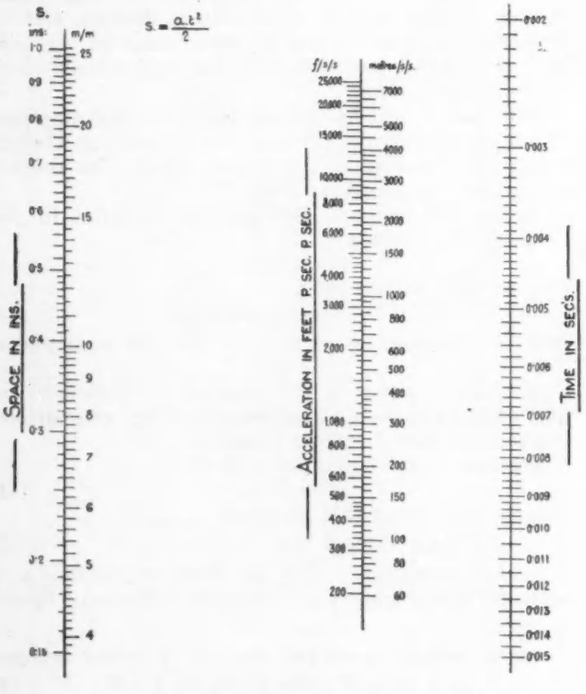


FIG. 9—ACCELERATION, TIME AND SPACE

the points representing the force and speed, a point is obtained on the reference line. Any straight line through this line will cross the weight and radius lines at suitable values.

In this way a choice can be made to suit the circumstances of the design with facility and without calculation as the line can be rotated about the point on the reference line until it crosses the other two at suitable values.

In engine design particularly there are many complicated calculations for which it is extremely useful to

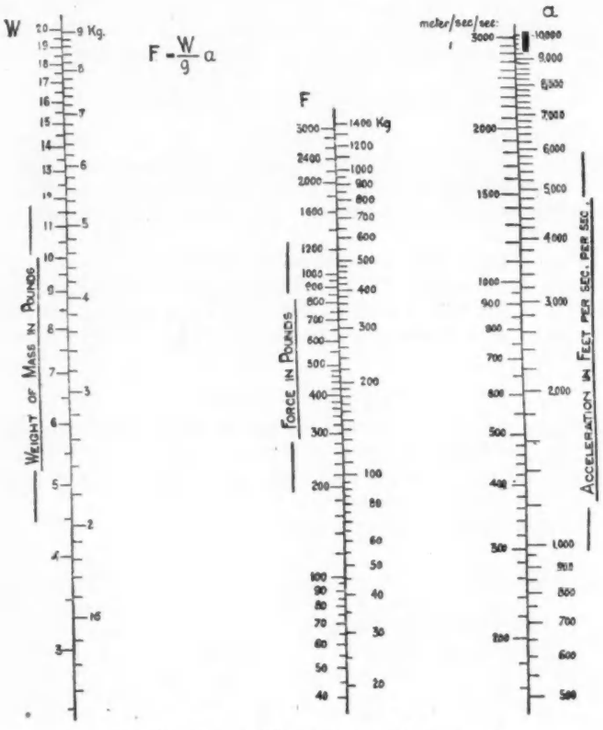


FIG. 10—FORCE, WEIGHT AND ACCELERATION

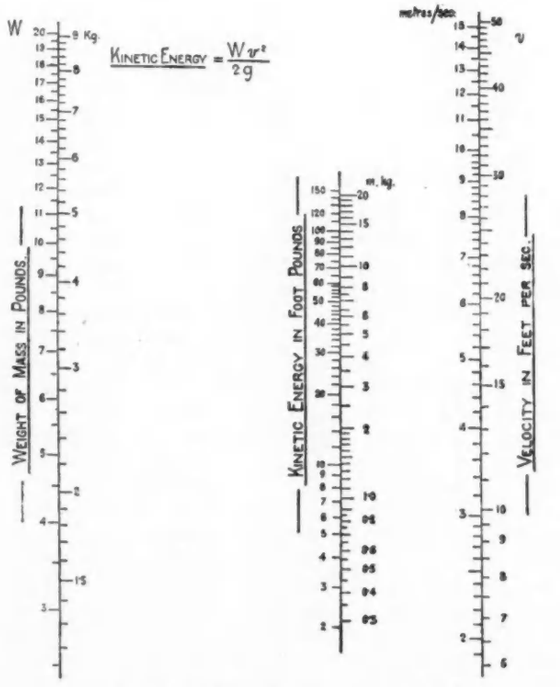


FIG. 11—KINETIC ENERGY DIAGRAM

have a simple manner of getting out accurate results, as much for the comparison of different arrangements and dimensions to produce the same result as for determining the exact proportions.

Engine Compression Ratio and Pressures

One such calculation is that dealing with compression ratio and pressure. (See Fig. 13 for formula.)

In this case there are really five variables to be dealt with, but two of these can be considered as a ratio and in this way a nomogram can be arranged with only four variables.

In this calculation there is V_1 the volume of the compression space and V_2, the volume swept by the piston plus the volume V_1.

This can be reduced to one variable as V_2/V_1 or R, the ratio.

Now this ratio to a certain power equals the compression pressure absolute divided by the initial pressure absolute.

The index required for the power of the ratio varies with certain engine conditions, but its generally accepted value is 1.29.

The nomogram Fig. 13 has been got out to solve this problem, and in it the line representing the index is graduated from 1.2 to 1.4, the point 1.29 being specially marked.

When the value of this index has been definitely established for any type of engine all other engines of the same type can have the ratio accurately determined by this diagram, use being made of the index so found.

The compression pressure also varies with the initial pressure in the cylinder and a line is included on the diagram for this also; this line is graduated as low as 10 lb. per sq. in. absolute, which is equivalent to the average absolute pressure at a height of 11,500 feet (3500 meters).

This scale is also carried beyond the normal average atmospheric pressure to allow of the diagram being of use when dealing with the design of engines using "stuffing."

The diagram is employed as follows:

Having fixed on the compression desired, the probable index, 1.29 if this has not otherwise been determined, and the initial pressure in the cylinder, about 14 lb. per sq. in. normally, draw a straight line from the desired compression pressure through the initial pressure to cut the line marked "reference line." From the point so found draw a second line to the index; this line will cross the ratio line at the correct value.

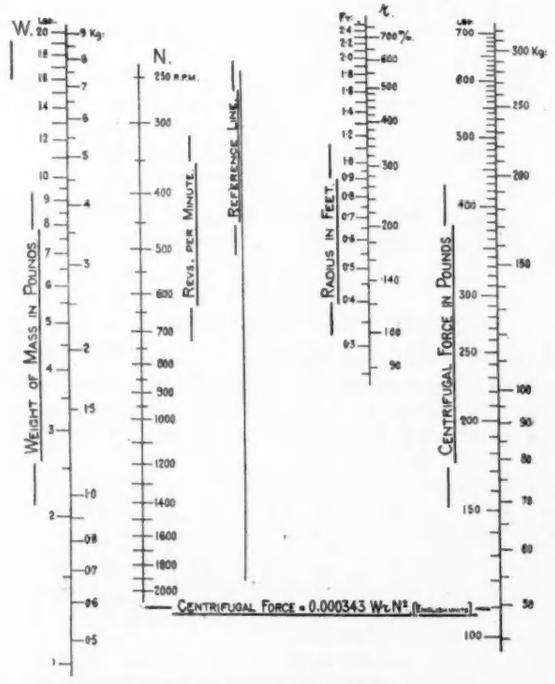


Fig. 12—Centrifugal Force Diagram

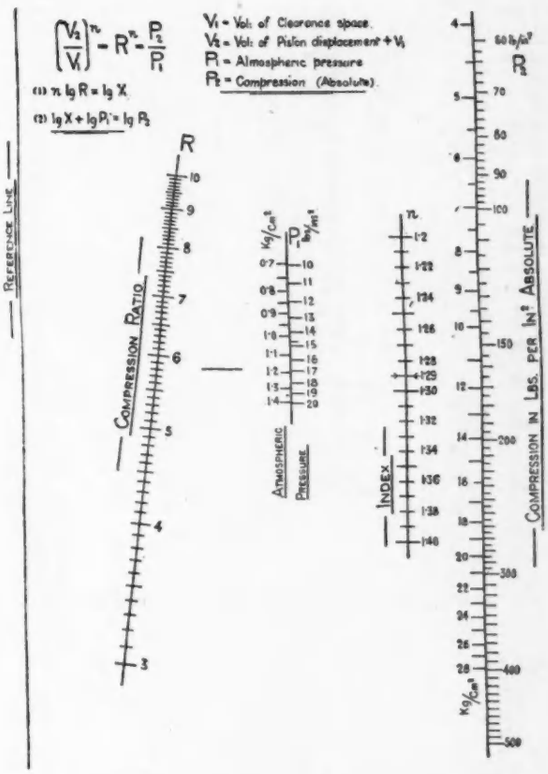


Fig. 13—Compression Pressure and Ratio

Shaft Torque

This being a four variable nomogram, it is divided into two parts, each of three variables.

The one is

$$n \log R - \log X = 0 \qquad (22)$$

This is a type B nomogram and the second is

$$\log X + \log P_1 - \log P_2 = 0 \qquad (23)$$

or a type A nomogram. Both types of diagram are therefore combined in this example.

In dealing with the problems of shaft design it is extremely useful to be able to make a direct comparison of the safe twisting moment of different shafts in which there may be variations both in diameter and materials. The nomogram Fig. 14 gives the data necessary for such a comparison for solid shafts.

This formula expressed in logarithms becomes

$$\log T_m - \log f - \log \pi + \log 16 - 3 \log D = 0 \qquad (24)$$

The diagram has been plotted to deal with shafts from ½ to 3½ in. diameter with working stresses of 5 to 40 tons (11,000 to 90,000 lb.) per sq. in., and is graduated

for metric units as well as British units, so that comparisons can be made with either system.

As hollow shafts largely replace solid shafts in modern

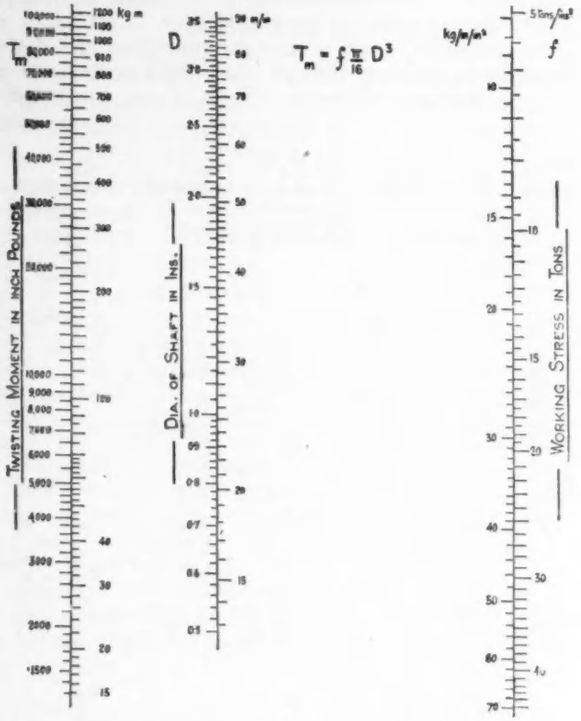


FIG. 14—TWISTING MOMENT OF SOLID SHAFTS

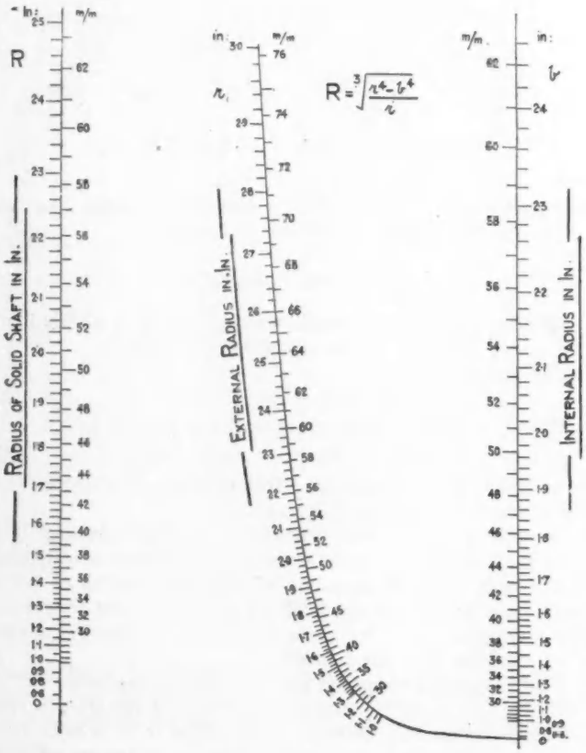


FIG. 15—SOLID AND HOLLOW SHAFTS COMPARED

engines it is convenient to be able to compare these also; the nomogram Fig. 15 has been prepared with this end in view.

The formula in this case becomes

$$R^3 + b^4/r - r^3 = 0 \qquad (25)$$

This is a type *C* nomogram.

With these two diagrams, Figs. 14 and 15, it is possible to make a comparison, with accuracy and extreme rapidity, of shafts in torsion including all sizes, both hollow and solid.

The average twisting moment on a shaft can be found from the formula:

$$T_m = 63{,}025Hp/N \qquad (26)$$

This can be written

$$\log T_m + \log N - \log 63{,}025 - \log Hp = 0 \qquad (27)$$

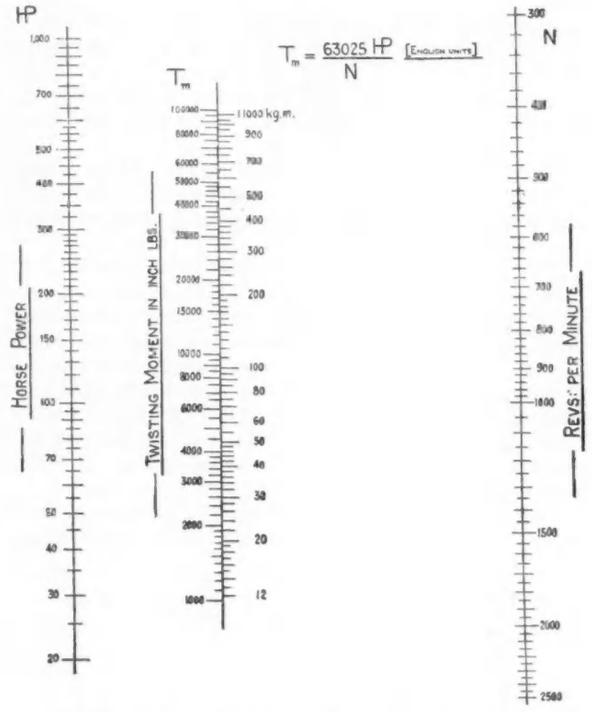


FIG. 16—TWISTING MOMENT FROM HORSEPOWER

and forms a type *A* nomogram as in Fig. 16, which is helpful as an addition to the two preceding, Figs. 14 and 15.

HELICAL SPRING DESIGN

In dealing with the question of helical springs some very ingenious but complicated diagrams have been got out and published at various times. The nomogram is again exceedingly helpful in facilitating, by simplifying, the necessary calculations.

The diagrams given here relate to springs designed with a stress of 35,000 lb. per sq. in. By slight modification of the diagram similar results can be obtained for any other stress desired. Generally such a stress as is here used is quite in accordance with practice for the small sizes of wire, but it should not be used for sizes larger than those given.

Being given the diameter of the spring required and the load it has to carry, say for example 1.5 in. and 20 lb.,

a line is drawn on Fig. 17 joining the load and the size required. This line strikes the line of wire sizes between 12 and 13 Imperial standard wire gage. The size one or two higher should be used according to the amount of movement required—take in this example the next size larger. A second line drawn from this size shows that such a spring will carry 26 lb. Having ascertained the size of the wire for the load refer to Fig. 18.

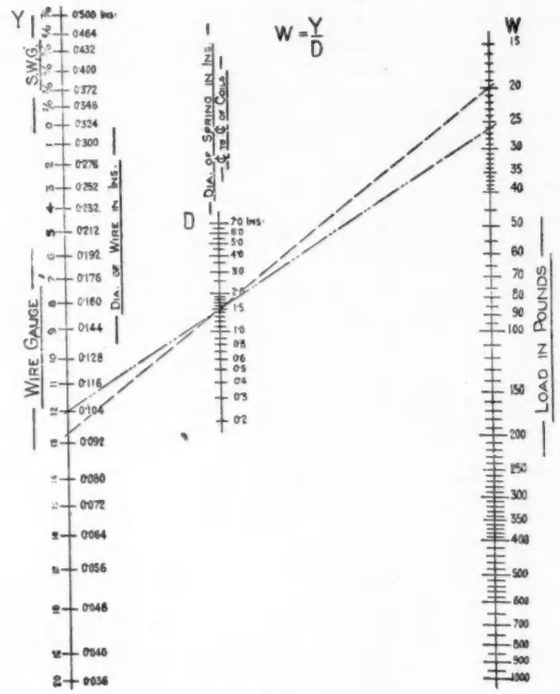


FIG. 17—HELICAL SPRING DIAGRAM

Again by joining the wire size to the spring diameter in this figure the safe compression or extension per coil is shown.

The following data are now available:

D. Diameter of spring, in.	1.5
W. Maximum safe load, lb.	26
W_1. Desired load, lb.	20
Y. Diameter of wire, in.	0.104
E. Safe compression, in.	0.5

From the above the compression for load (*E*) will be

$$E \times W_1/W \qquad (28)$$

or in the example $0.5 \times 20/26 = 0.385$.

The space between the coils will be therefore

$$E - EW_1/W \qquad (29)$$

or in the example $0.5 - 0.385 = 0.115$,
and the pitch of the coils will be

$$Y + E - EW_1/W \qquad (30)$$

or in the example $0.104 + 0.115 = 0.219$.

Having obtained this result refer to Fig. 19, and draw a line from the desired length of spring through the pitch of coils as obtained above, and the result will give the number of free coils necessary, in this case 14.

Now it is also known from the data that the pitch of the coils when free is

$$E + Y \qquad (31)$$

or in the example $0.5 + 0.104 = 0.604$.

A line from the number of coils through this point on the pitch line gives the free length of the spring.

As the pitch when the spring is close coiled will be *Y* alone, by drawing a line through this point on the pitch line, the length of the spring in this condition can be obtained.

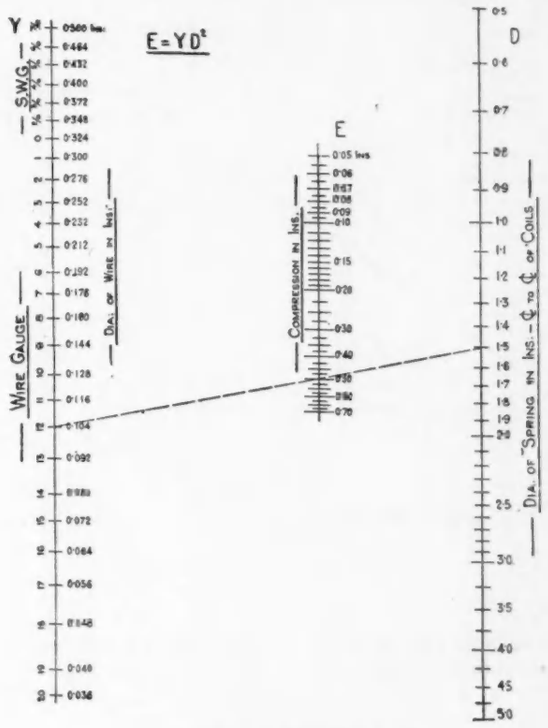


FIG. 18—HELICAL SPRING DIAGRAM

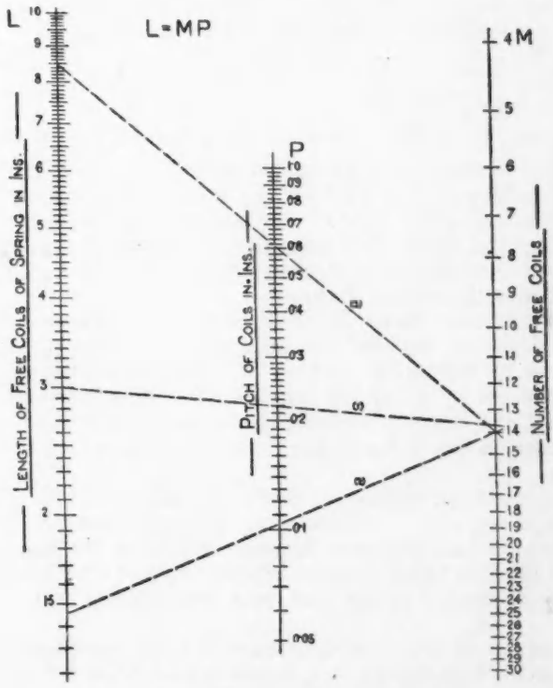


FIG. 19—HELICAL SPRING DIAGRAM

All the required data for the spring have now been obtained, and a complete diagram of the spring itself giving these data in the most easily used form can be made; such a diagram has been made for the example and is shown in Fig. 20. Hence C is the free length of the spring of 14 free coils plus 1 dead coil, B is its length under a load of 20 lb., and A its length close coiled. From this diagram the load and the deflection

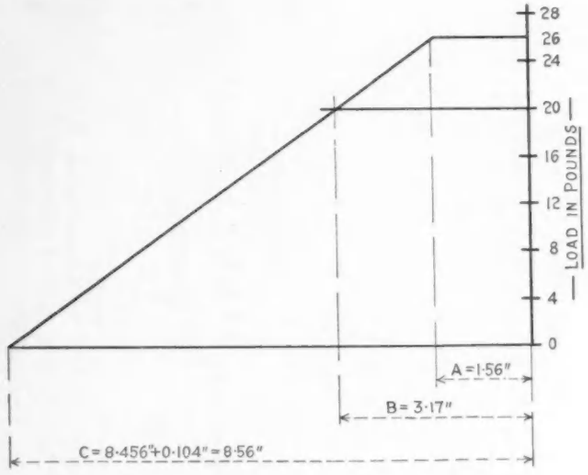


FIG. 20—HELICAL SPRING DIAGRAM

still available can be found for any other condition with the assistance of the scale on the right-hand side.

ENGINE DESIGNS

In getting out designs of an engine, in many instances it is desired to arrange for the swept volume to be a certain fixed amount per revolution. The swept volume per cylinder can be found from the formula:

$$V_c = D^2 S\pi/4 \qquad (32)$$

or in logarithmic form

$$\log V_c + \log 4 - \log \pi - 2 \log D - \log S = 0 \qquad (33)$$

This is shown as a nomogram in Fig. 21.

It will be evident that for any volume on the V_c scale, by rotating a line around the point on this scale representing the desired amount, all dimensions of cylinders, that is, diameters and strokes giving this volume, can be read directly off the diagram.

Two further scales, however, are added. These scales J and Q can be used for obtaining the total cylinder volume by taking the number of cylinders, or the working volume by using the number of working strokes on scale J and drawing a straight line to the volume of one cylinder on the V_c scale; the result will be given on the Q scale.

The working volume is useful for all calculations of horsepower, and it will be seen that by this method of expression this diagram becomes available for calculations relating to all engines, whether two or four stroke, single or double acting, and with any number of cylinders.

Engines of varying dimension can be compared by taking the horsepower at a standard mean effective pressure and revolutions per minute. The actual performance can also be compared with the rated performance on the same basis.

For this purpose the nomograms given in Figs. 22 and 22a can be used.

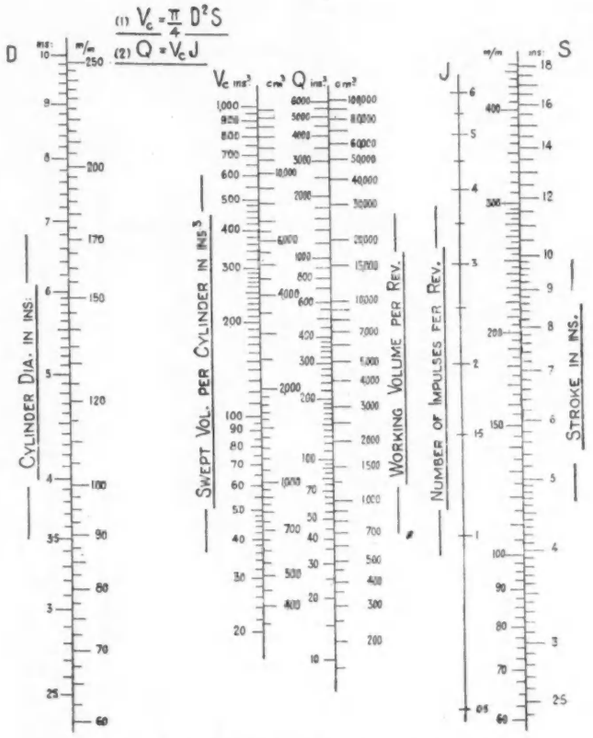


FIG. 21—CYLINDER AND WORKING VOLUME

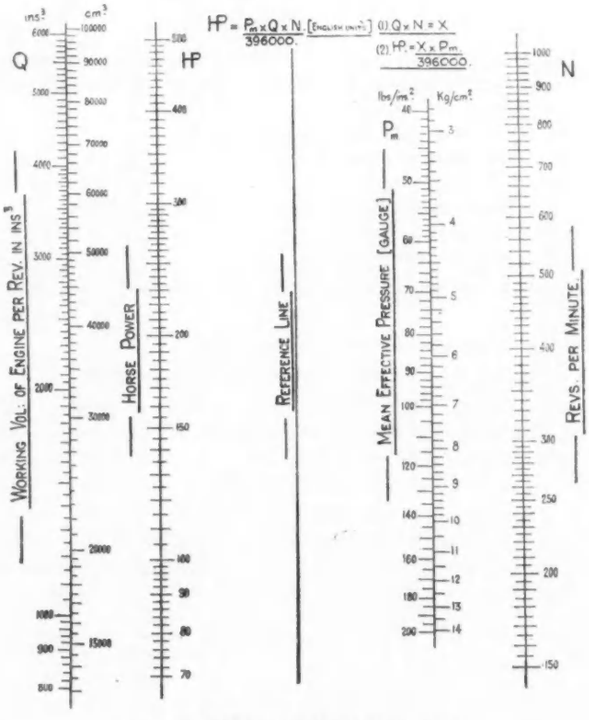


FIG. 22—HORSEPOWER FROM M. E. P.

In this case also a four variable nomogram is necessary as the formula is:

$$Hp = P_m QN/396{,}000 \qquad (34)$$

This can be written in logarithmic form and divided into two parts, as follows:

$$\log Q + \log N - \log X = 0 \qquad (35)$$

and

$$\log Hp + \log 396{,}000 - \log X - \log P_m = 0 \qquad (36)$$

If it is found at any time that the horsepower scale on Fig. 22 does not go sufficiently high, the same scale of Fig. 22a can be used as an addition to it by setting the two in line with the distance from the 100 on Fig. 22 to the 200 on Fig. 22a, measuring the same length as the distance from the 200 to the 400 on the latter figure.

These diagrams are used by joining the necessary point on the Q scale to that on the N scale, so getting a point on the reference line. The straight line from this point through the P_m line cuts the horsepower line at the correct horsepower. This diagram, of course, gives the indicated power.

To obtain the area of the inlet and exhaust pipes the working volume Q can also be used. For solving this

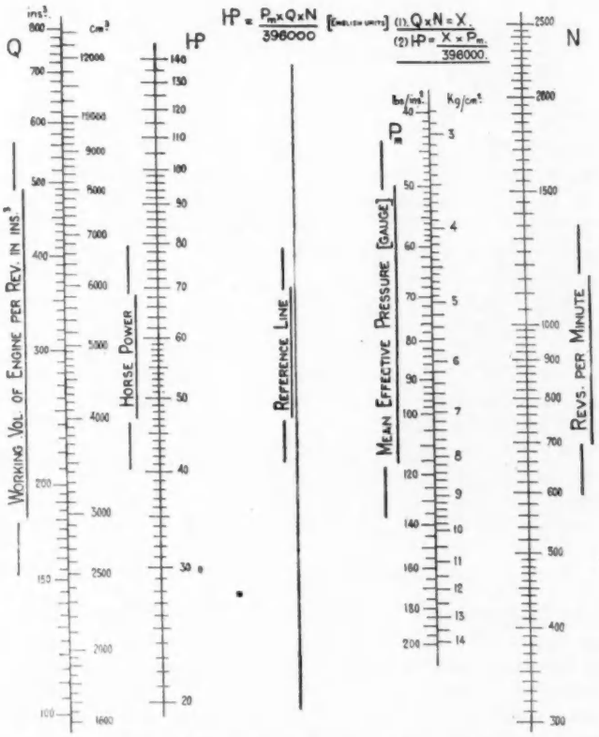


Fig. 22a—Horsepower from M. E. P.

problem the two nomograms Figs. 23 and 23a have been prepared.

The formula in this case is:

$$v_g = QN/180\,\pi\,D_1^2 \qquad (37)$$

This written in logarithmic form and divided into two parts to deal with the four variables becomes:

$$\log Q + \log N - \log X = 0 \qquad (38)$$

$$\log v_g + \log 180 + \log \pi + 2 \log D_1 - \log X = 0 \qquad (39)$$

Although the preceding paragraph and the diagrams therein deal with the question of the main inlet and exhaust pipes yet the valve area cannot be obtained in this way nor the area of the individual pipes leading to each cylinder, as in the former case all the gas to or from the engine is presumed to be passing. The valves only deal with the actual volume drawn into the cylinder and this has to pass in during one stroke only. A further formula

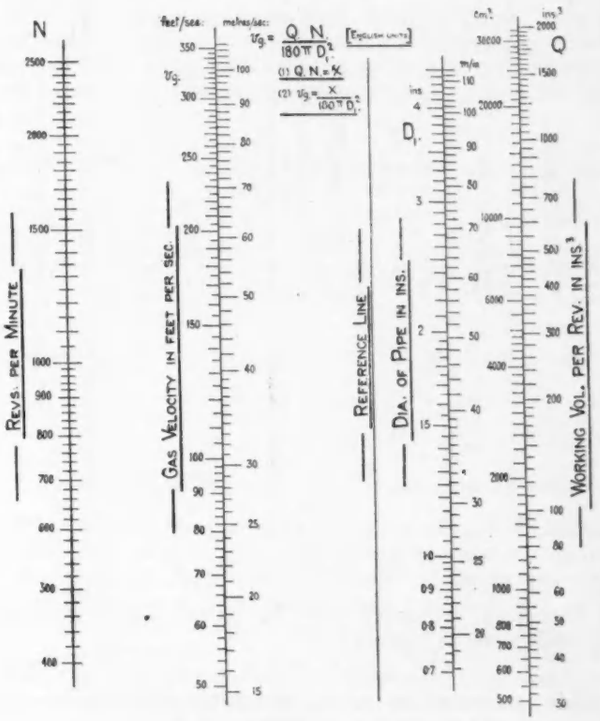


Fig. 23—Pipe Sizes for Engines

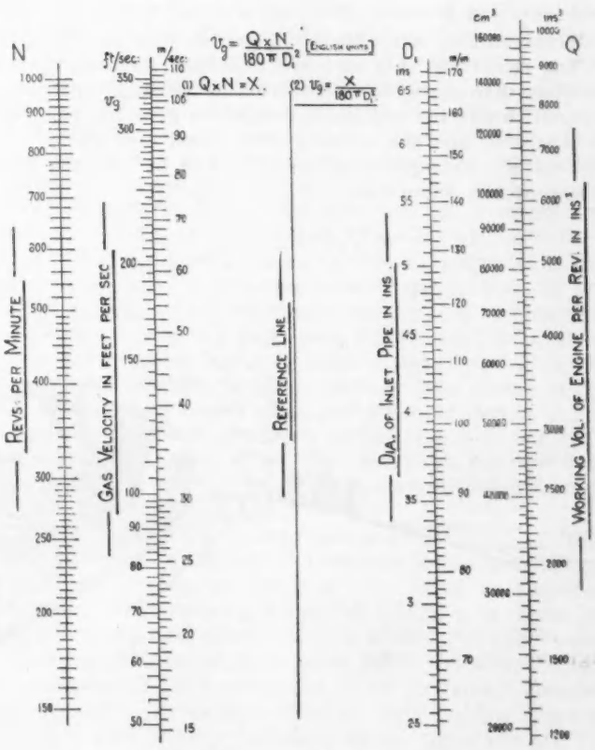


Fig. 23a—Pipe Sizes for Engines

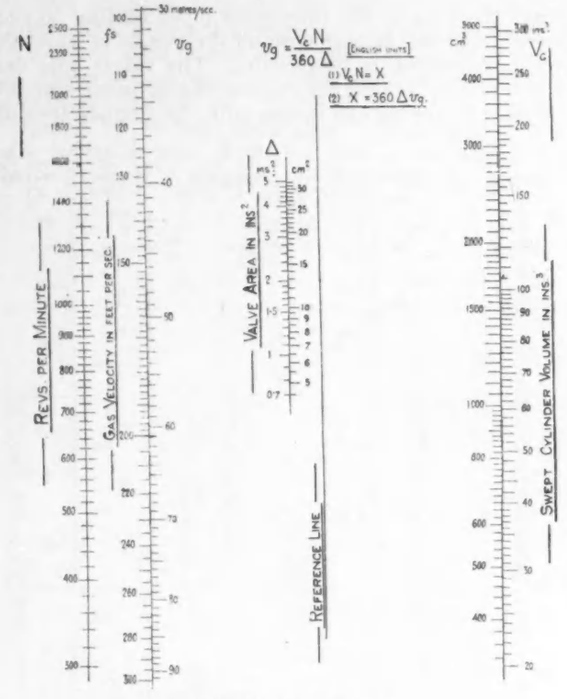


FIG. 24—VALVE AREA

is therefore necessary for the valves and individual cylinder pipes as follows:

$$v_g = V_c N/360\,\Delta \qquad (40)$$

This is treated in logarithmic form and divided into two parts and becomes as follows:

$$\log V_c + \log N - \log X = 0 \qquad (41)$$

and

$$\log X - \log 360 - \log \Delta - \log v_g = 0 \qquad (42)$$

The resulting nomogram is given in Fig. 24.

The results in this case are expressed as areas rather than as diameters, as the valve may perhaps not be arranged to lift the necessary height to give full area due to diameter and therefore in this event the area should be treated as composed of the height of lift and the perimeter of the valve seat.

How to Make Readings

It will be evident that the subject of the paper is but sketchily dealt with, but it is hoped that enough has been said to show its importance and utility.

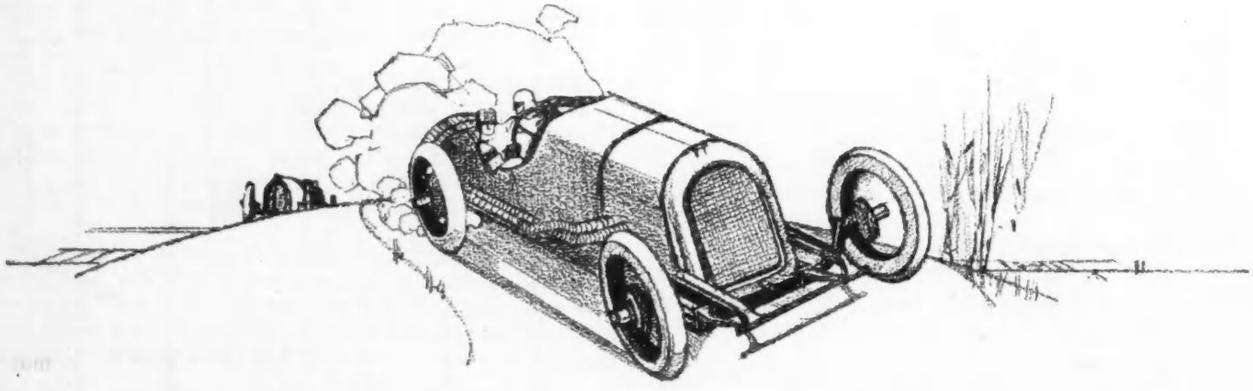
It is as well to bear in mind that a nomogram should always be made as nearly square as possible in order that the lines may cross one another approximately at right angles; in this manner the errors of reading are much reduced.

A piece of black thread or a celluloid rule with a fine line on it in contact with the paper, probably give the best means of reading the diagrams, but neither of these can be used very successfully with a four variable nomogram, unless the trouble is taken to graduate in some form the reference line. With four variables a straight edge and fine pencil point is probably the best means of obtaining quick results.

One word of warning must be given about using four variable nomograms, and that is that it is necessary to read only from the scales and the reference line in the correct order. This order can be found from the formulas given on the diagrams, X in each case expressing the unknown represented by the point on the reference line.

SYMBOLS USED IN THE PAPER

a = Acceleration or number
f = Stress
g = Acceleration due to gravity or 32.1717 ft. per sec. per sec.
n = Index
r = Radius
t = Time in seconds
v = Velocity
v_g = Gas velocity
x = Power
D = Diameter
D_1 = Diameter of inlet pipe
E = Compression or extension of helical spring
F = Force
J = Number of impulses per revolution
L = Length of spring
M = Number of coils of spring
N = Revolutions per minute
P = Pitch of coils of spring
P_m = Mean effective pressure
P_1 = Compression pressure (absolute)
P_2 = Initial pressure (absolute)
Q = Working volume per revolution of engine
R = Compression ratio
S = Space or stroke
T_m = Twisting moment
V_c = Cylinder volume
V_1 = Volume of clearance space
V_2 = Volume of piston displacement plus volume of clearance space
W = Weight of mass or load in lb.
X = Unknown in formulas and diagrams
Y = Wire gage (Imperial Standard)
Δ = Area



SIDE GUIDE & GRIPPER

Losses of Oil in Storage

THE following information is taken from Bulletin No. 155 (Petroleum Technology No. 41) of the Bureau of Mines, entitled "Oil Storage Tanks and Reservoirs," and written by C. P. Bowie. Although the information concerns more particularly the problems of the oil producer and distributor, it is also of interest to the oil consumer.

Oil losses by seepage from steel tanks and from well-constructed concrete-lined reservoirs can be considered practically nil. From unlined earthen reservoirs, however, seepage losses may be very large. It is difficult to determine just what these losses are for the reason that most of such reservoirs are used as emergency containers, the oil put into them coming unmeasured from flowing wells.

However, there is a record of a 500,000-bbl. unlined reservoir in the Kern River field, California, that had to be abandoned on account of the excessive seepage losses. Although the reservoir was in use only a short time, pits dug subsequently in the bottom disclosed that the oil had already penetrated for a depth of more than 20 feet.

Another company in the same field found that its losses from both evaporation and seepage from heavy oil of 14 deg. to 16 deg. Baumé, stored in a 1,000,000-bbl. reservoir over a period of six years, when the reservoir was kept approximately full, averaged 0.58 per cent a month, or 6.96 per cent a year. After the reservoir had been lined with concrete the losses were reduced to approximately 0.176 per cent a month, or 2.112 per cent a year. Assuming that the losses by evaporation were the same for the lined as for the unlined reservoir, which was practically the case, as oil was constantly being put into and withdrawn from the reservoir under both conditions, the saving of oil due to the lining was 4.85 per cent per year. In other words, if the reservoir were kept full the yearly saving at the present market price of oil (about $1.00) would amount to $48,500 a year, which, placing the cost of lining at 5c. per bbl., would pay for that lining in a little more than a year's time.

Losses by Evaporation

If we knew definitely the volume of useful hydrocarbon products that "vanish into thin air" from the wells, the transportation systems, the storage farms, and the refineries of the United States in one single year's time we might well be staggered by the size of the figures. To form some realization of their gigantic proportions one needs only to stand in the vicinity of a flowing well newly brought in, and witness the volumes of gases rising like exaggerated heat waves from the well itself, from the flow tanks in which the oil is being collected, from the sump into which it has overflowed, and from every surface exposed to the atmosphere. The greatest unmeasured loss, of course, takes place in the vicinity of the well. Nevertheless, this loss continues in a large measure, especially as regards light oils, through the gathering systems, the transportation systems, and the receiving tanks at the refineries, and even from oil of low gravity there is a continual stream of the light hydrocarbons escaping from its surface as long as it remains in storage.

The following data from Port Arthur, Texas, give a comparison of the losses in a wooden-roof tank and in an all-steel tank with tight roof, having one central vent pipe leading the escaping gases to a point outside the fire levee.

Comparative Losses of Oil from a Wooden-Roof Tank and from a Steel-Roof Tank

Kind of Tank	Gravity of Oil in Tank, Deg. Baumé	Depth of Oil in Tank, Ft. In.	Loss		Time in Storage, Mo. Days	Percentage of Loss	Percentage of Loss in a Year
			Inches	Barrels			
Wooden-roof	55.9 55.2	28 11 27 11½	11½	1759	1 10	3.39	30.5
Steel-roof	54.7 54.6	29 3½ 29 1⅛	2⅜	363	1 17	0.687	5.32

Losses From Wooden and Steel-Roof Tanks

The highest temperature recorded at Port Arthur during the observations was 100 deg. fahr. Another Texas company found, from a record of the evaporation of naphtha stored in a wooden-roof tank and in a steel-roof tank for a period of six weeks, that the loss from the wooden-roof tank was 3.1 per cent, while the loss from the all-steel tank was 0.42 per cent. On this basis the annual loss from the wooden-roof tank would be 25.20 per cent, and from the all-steel tank 3.40 per cent, or a difference in favor of all-steel construction of 21.80 per cent. With gasoline at, say, 15c. per gal. at the refinery this would amount to $75,500 a year in a 55,000-bbl. tank, indicating that it is the height of folly to attempt to store gasoline even temporarily in a wooden-roof tank.

A California company reports that 18 deg. Baumé asphaltum-base oil placed in storage in a concrete-lined reservoir with wooden roof showed a loss of 5.52 per cent after a year's time, and that during this period the gravity of the oil was reduced to 15.5 deg. Baumé. So far as is known all of this loss was by evaporation. The same company states that "fuel oil of more than 14 deg. Baumé should not be stored in reservoirs. The evaporation and leakage increase in proportion to the rise in gravity. Our experience has been with concrete-lined reservoirs in the Kern field (California) with gravity of oil ranging about 14 deg. Baumé; out of eight lined reservoirs our smallest average loss in one reservoir was 0.35 per cent a year; our greatest loss in one of these reservoirs for the same period was 1.92 per cent, and the average loss in all the reservoirs for the year was 1.056 per cent." These reservoirs have wooden roofs covered with roofing paper.

The table following, comprising a compilation of foregoing data, would indicate the average losses by evaporation from various gravities of distillates and crudes. However, the figures can not be taken as a basis on which to estimate closely future losses, for the reason that although most of them seem fairly reliable, it must be remembered that petroleum is an extremely complex mixture of hydrocarbon combinations having various gravities and various boiling points. A crude oil, for instance, with a gravity of 40 deg. Baumé may be com-

SIDE GUIDE & GRIPPER

posed of some of the heavier hydrocarbons and some of the very light hydrocarbons, whereas another oil, with the same gravity, 40 deg. Baumé, may be composed of hydrocarbon compounds varying little from that gravity. The first oil would lose rapidly by evaporation when placed in storage, whereas the latter, although originally of the same gravity, would evaporate much more slowly.

The summary does serve to show that there is considerable loss from all grades of oil when placed in storage, and that the evaporation from some grades of fresh oil is alarmingly large. Although the figures are admittedly incomplete, as the majority of operators have no reliable information as to exact losses from evaporation, it is hoped that publication of the figures may assist to stimulate producers and refiners generally to a more systematic effort toward determining the real magnitude of such losses.

SUMMARY OF LOSSES OF OIL IN STORAGE BY EVAPORATION

Gravity of Oil, Deg. Baumé	Type of Container	Average Monthly Loss, per Cent	Average Yearly Loss, per Cent	Remarks
60 to 55 distillate.	Wooden-roof tank, paper top	....	27.8	
Do.	All-steel tank	....	4.36	Plain top; no water seal
Do.	Do.	....	3.76	Water topped and lagged
50 to 43 distillate.	Do.	....	2.00	
44.5 to 44.	Wooden-roof tank, sheet-iron top	....	2.02	Pennsylvania crude
41 to 28 crude.	All-steel tank	....	2.50	Oklahoma crudes
38 to 30 crude.	Do.	....	1.00	Texas and Louisiana crudes
Do.	Wooden-roof tank, sheet-iron top	....	1.61	Kansas and Oklahoma crudes
33 crude.	Do.	....	1.40	Illinois crude
25 to 18 crude.	Do.	....	.70	Texas and Louisiana crudes
28 to 22 crude.	Do.	1.30	....	Fresh California crudes
18 crude.	Wooden-roof tank, paper top	....	5.52	California crude
16 to 14 crude.	Unlined reservoir, wooden roof	....	6.96	Do.
14 crude.	Concrete-lined reservoir, wooden roof	....	.95	Do.
13.4 crude.	Wooden-roof tank, paper top	....	.66	Do.

DEVICES FOR LESSENING EVAPORATION LOSSES

Why does oil evaporate? The accepted theory regarding the constitution of matter and the nature of heat assumes that all liquids are composed of molecules which are held together by mutual attraction. When a liquid is warmed above —273 deg. cent. the molecules are in constant and rapid motion, and, as a result there are spaces between them. As heat is applied to the liquid the molecules move more and more rapidly and strike against each other with greater force, separating further against the force of cohesion. Molecules near the surface of the liquid and vibrating rapidly pass out from it. Some are drawn back again into the liquid by cohesion, but some escape into the air above the surface. If the vessel containing the liquid is open, in time all may escape. However, if the vessel is tightly closed the molecules cannot escape from it, and even though it be only partly filled with liquid the air above the surface soon becomes so filled with vibrating molecules that the number leaving the surface of the liquid in a given time is just equal to the number going back into it. The air above the liquid is then saturated and evaporation ceases. If the temperature of the liquid in the closed vessel is increased, vaporization again takes place, but ceases as soon as the air in the vessel above the liquid becomes saturated for that temperature. However, the pressure in the vessel is increased. If the warm saturated air is cooled, some of the vapor condenses and returns to the liquid and the pressure is decreased.

Devices for preventing evaporation losses should be designed with two purposes in view—first, to keep the temperature of the oil in the vessel as low as possible, and, second, to make the container as tight as practicable.

Water-Seal Tops

Perhaps the most common method of decreasing evaporation losses in an oil-storage tank is by the water-seal top. This form of construction is usually applied to small tanks of 1000-bbl. to 5000-bbl. capacity, such as run-down tanks in which naphthas and light refined products are received from the tail houses. The construction of the tank is similar to other steel tanks except that it has a flat roof constructed from riveted plate calked and made water-tight, which is placed about six inches below the upper edge of the shell. The space inclosed above the plate is then filled with water that can be kept constantly circulating, thus keeping the tank and its contents cool.

Tests were made with small tanks of 100-bbl. capacity, some of which had plain sheet-iron tops and others water tops. Each water-top tank was also protected with a sheathing of 1-in. boards surrounding the sides and the top of the tank and at a distance of about 18 in. from it. The use of these protective devices decreased the losses by evaporation as much as 14 per cent.

Sprinkling Tanks with Water

A tank-sprinkling device used by a Pennsylvania company is made on the principle of a lawn sprinkler and is placed on the roof at the center of the tank. During hot weather the spraying device is kept in constant operation. The water on leaving the roof is deflected against the sides of the tank by a baffle plate so that it passes in a film over practically the whole outside surface of the tank.

Gasometers

A type of gasometer in use by the Shell Oil Co. of California for the collection of the light gases is attached to a battery of gasoline-storage tanks of gas-tight construction. Its purpose is to take care of the expansion and contraction, owing to changes in temperature, of the light gases filling the space between the surface of the gasoline and the tops of the tanks. If one tank in the battery is being filled while another is being emptied, the function of the gasometer is also to conserve the gases discharged from the tank being filled. Such gases ordinarily escape into the atmosphere, but the gasometer causes them to be returned to a tank being emptied. There seems no reason why such a system could not be applied to run-down tanks and the like, a provision being made whereby any surplus gases not taken care of by the gasometer could be drawn off and condensed, or otherwise profitably disposed of.

Tile-Encased Tanks

Tile-encased tanks are also in use. This type of protection, in the author's opinion, would be much more effective if some type of casing were applied to the roof of the tanks as well as to the sides. The method of protection employing ordinary hollow building tile such as is used in modern building construction is said by the users to reduce evaporation losses 4 to 6 per cent.

Burying Tanks

Partly or wholly burying oil tanks in the ground is a common practice among some refiners. However, the

ultimate economy is questionable, as depreciation of the shell from soil corrosion may be rapid, and leaks, unless relatively large, are hard to detect and expensive to repair.

Concrete Tanks

Small reinforced-concrete tanks about 34 ft. in diameter by 10 ft. high are being built by several refineries in various parts of Oklahoma. Each of these tanks has a capacity of about 1500 bbls. and is buried in the ground to within 3 or 4 ft. of the top. The roof of the tank is 4 in. thick, the walls 8 in. and the bottom 5 in. The roof has a slope from the center to the edge of about 1 in. in 4 ft., and the bottom a slope from the side walls to the center where a sump 4 ft. in diameter by 3 ft. deep is constructed. A swinging pipe can be lowered into the sump when it is desired to drain the entire contents of the tank.

After the forms inside the tank have been removed from the walls and bottom these surfaces are given one to three coats of neat cement. When this has thoroughly dried, several coats of a commercial oil-proofing paint are applied.

One such tank has been in use by an Oklahoma company for the storage of 42-deg. Baumé oil since October, 1916. Thus far the tank has given complete satisfaction, and the erection of additional tanks in the near future is proposed. The El Paso & Southwestern Railroad Co., at various places along its system, has for the past five years been storing fuel oil of 24 to 38-deg. Baumé in underground circular concrete tanks about 12 ft. in diameter by 6 ft. deep. Tanks that have been in use five years have been examined inside and out, but no signs of leakage were discovered. At present the company has twelve such tanks, and their adaptability to oil storage has proved so satisfactory that more are in process of construction. No oil or waterproofing compounds are used.

A local electric company at St. Helena, Cal., built a rectangular reinforced-concrete tank in 1911. This tank is 16 ft. long, 14 ft. wide and 5½ ft. deep, having a capacity of approximately 10,000 gal. The bottom is 20 in. thick and the sides 8 in. at the bottom, tapering to 5 in. at the top. Both the sides and the bottom were reinforced with steel rods. At the time the tank was constructed it was coated inside with a solution of sodium silicate. However, after 18 months of service the coating had become practically useless. The tank at this time was examined inside and outside by digging pits, but as no leakage was found no further attempt at oil proofing was made. The roof of this tank is made of wood covered with roofing paper. As a means of lessening evaporation losses and providing a run-off for rain water, as the wooden roof is practically flat, a second corrugated-iron roof of proper pitch has been constructed about 3 ft. above the first roof, allowing free circulation of air between the two.

Painting Tanks Light Colors

Many oil operators, especially throughout the Eastern and the Middle Western fields, have adopted white or light-colored paints for storage tanks. It is reported that tests have demonstrated that evaporation from tanks painted white averages about 1 to 1½ per cent less than from tanks painted red, and about 2½ per cent less than from tanks painted black. These figures have not been verified, but tests made by the Institute of Industrial Research* show that dark-colored paints absorb heat to a considerable degree, and paints presenting a highly glossy surface are less absorptive of thermal rays than those presenting a matte surface.

Experiments were conducted wherein small tanks containing benzine were painted in various colors (gloss finish) and then subjected to the rays of a powerful arc-light for 15 minutes. At the end of that period the rise in temperature was as follows:

RISE IN TEMPERATURE OF BENZINE STORED IN TANKS OF VARIOUS COLORS

Color of Paint or Covering	Rise in Temperature, Deg. Fahr.
Tin plate (tank plated with tin)	19.8
Aluminum paint	20.5
White paint	22.5
Light-cream paint	23.0
Light-pink paint	23.7
Light-blue paint	24.3
Light-gray paint	26.3
Light-green paint	26.6
Red iron oxide paint	29.7
Dark prussian blue paint	36.7
Dark chrome green paint	39.9
Black paint	54.0

Tin plating and aluminum paint, as will be seen, gave the best results. However, neither of these finishes is practicable for outside work, as iron coated with tin corrodes rapidly, and aluminum paint soon loses its gloss and becomes flaky. The rise in temperature of the benzine in the tank painted black was 31.5 deg. fahr. greater than the rise in the tank painted white, or 140 per cent. Although results such as obtained by these laboratory experiments could not be expected in actual practice, there is undoubtedly a decided advantage to be gained by painting storage tanks white.

*The heat-reflecting properties of colors applied to oil and gas storage tanks. By H. A. Gardner. Circular 44, Paint Mfg. Assn. of U. S., Educational Bureau, Sci. Sec., January, 1917, p. 1.

SIDE GUIDE & GRIPPER

Current Standardization Work

THE Divisions of the Standards Committee are planning to increase their activity beginning with September, when several meetings will be held. The dates of the meetings, however, have not as yet been definitely decided upon. In conducting the standardization work of the Society precedence will be given to subjects closely related to the Government's prosecution of the war.

Ball and Roller Bearings Division Meeting

A meeting of the subdivision on roller bearings of the Ball and Roller Bearings Division and of manufacturers' representatives was held June 25th in the Hotel Statler, Cleveland.

The Ball and Roller Bearings Division, at its meeting in Dayton last June, decided to place the entire matter of roller bearing standardization before roller bearing manufacturers and to have a subdivision analyze present practices carefully and prepare roller bearing specifications covering the desired interchangeability and uniformity of sizes suitable for recommendation as S. A. E. standards.

The personnel of the subdivision on roller bearings is as follows: H. J. Porter (chairman), and T. V. Buckwalter, Timken Roller Bearing Co.; W. C. Baker, Standard Parts Co.; G. R. Bott, Norma Company of America; F. M. Germane, Standard Roller Bearing Co.; C. T. Hagenlocher, Wright Roller Bearing Co.; L. R. Heim, Ball & Roller Bearing Co.; A. M. Laycock, Sheldon Axle and Spring Co.; R. G. Schaffner, Bower Roller Bearing Co.; C. W. Spicer, Spicer Mfg. Co.; R. E. Wells, Hyatt Roller Bearing Co.

Owing to different characteristics in taper roller and ball bearings, requiring different fits and tolerances for each class of bearing, and allowances for adjustments for taper roller bearings, the suggestion had been made that the present S. A. E. roller bearing standards be withdrawn, in so far as their application to taper roller bearings is concerned. As a result of this suggestion, the subdivision has undertaken to prepare recommendations for roller bearing dimensions and tolerance specifications in which taper and straight roller bearings will be interchangeable and in which both will be interchangeable with ball bearings, if possible.

Bearing manufacturers have made many special designs for individual customers. These have been ordered in a great variety of sizes, the number of which could be materially reduced with the cooperation of purchasers. Furthermore, the present S. A. E. narrow roller bearing series follows the light ball bearing series in bore and outside diameter, and the wide roller bearing series follows the medium ball bearing series.

Metric and Inch Sizes

At the time of the adoption of the present metric roller bearing series, manufacturers considered that they were warranted, although there was then but little information available for properly coordinating metric and inch sizes. The majority of roller bearings are now made in inch dimensions, although a standardized series of inch sizes is not available in published form. One member stated that at least 95 per cent of all roller bearings are made in inch dimensions. Furthermore, practically no roller bearings are made or used in European countries. On the other hand, the use of metric sizes is growing rapidly, owing to present Government requirements.

It was decided to take under consideration for standardization a metric series of roller bearing sizes; also to consider, as an alternative, a rational series of inch sizes, to comprise the least number necessary to cover the present ranges. All sizes selected are to be from among those now used by manufacturers, and no new inch sizes are to be designed. If any new designing is necessary, it will probably apply to the metric sizes only.

In order to work out as soon as possible the best specification for standardized roller bearings, the subdivision invites the full cooperation of not only roller bearing manufacturers but others interested in this subject.

SOCIETY STANDARDS MANAGER TAKES UP WORK FOR NAVY

AT THE request of Admiral D. W. Taylor, chief of the Bureau of Construction and Repair, U. S. Navy, the Society has released M. W. Hanks from his work as Standards Manager. He has now become aeronautical mechanical engineer with the Navy Department in charge of the standardization of specifications for aircraft materials and fabricated parts. Considerable cooperative work has been done in the past with the Navy Department through the Aeronautic and Marine Divisions of the Standards Committee of the Society, and it is expected that this will be carried on even further in the future.

Mr. Hanks has been in charge of the standardization activities of the Society for nearly a year and a half, and it is largely due to his concentration and enthusiasm that the work of the Standards Committee has been expanded to keep pace with the war activities of the Nation. This is particularly true of the work done in the aeronautic, marine, motorcycle and closely allied fields.

During the same period Mr. Hanks has been particularly active in carrying on the general standardization work of the Society, much of which has been continued, even though it is not directly related to war activities.

Standard Ratings for Tractors

How They Are Saving Money for Farmer and Manufacturer

THIS is the first of a series of articles pointing out how manufacturers can save time and money by the use of S. A. E. standards, not only in the engineering and production departments, but also in filling orders, in shipping and in correspondence.

Drawbar Rating

Without a definite uniform basis of rating the drawbar pull of a tractor, how can the farmer contemplating purchase compare the work that the various tractors will do? If a manufacturer rated his tractor on the basis of a maximum average pull for one hour, and another manufacturer rated on a basis of 80 per cent of the guaranteed continuous pull for two hours, one would say that the latter rating was more conservative and would not overwork the engine. Besides this the farmer wants a conservative rating because of the great variation in power required to work different soils, and he is justified in demanding that his tractor will pull its rated load continuously without excessive repairs. If the tractor fails in this the farmer blames the manufacturer, although it is not unlikely that the tractor is a good one when operated at a reasonable rating. A conservative rating is also a big protection to the manufacturer as it assures less overloading and longer life of the tractor.

To insure satisfactory service to the farmer, many progressive manufacturers are now rating the drawbar pull of their tractors according to the S. A. E. Standard.

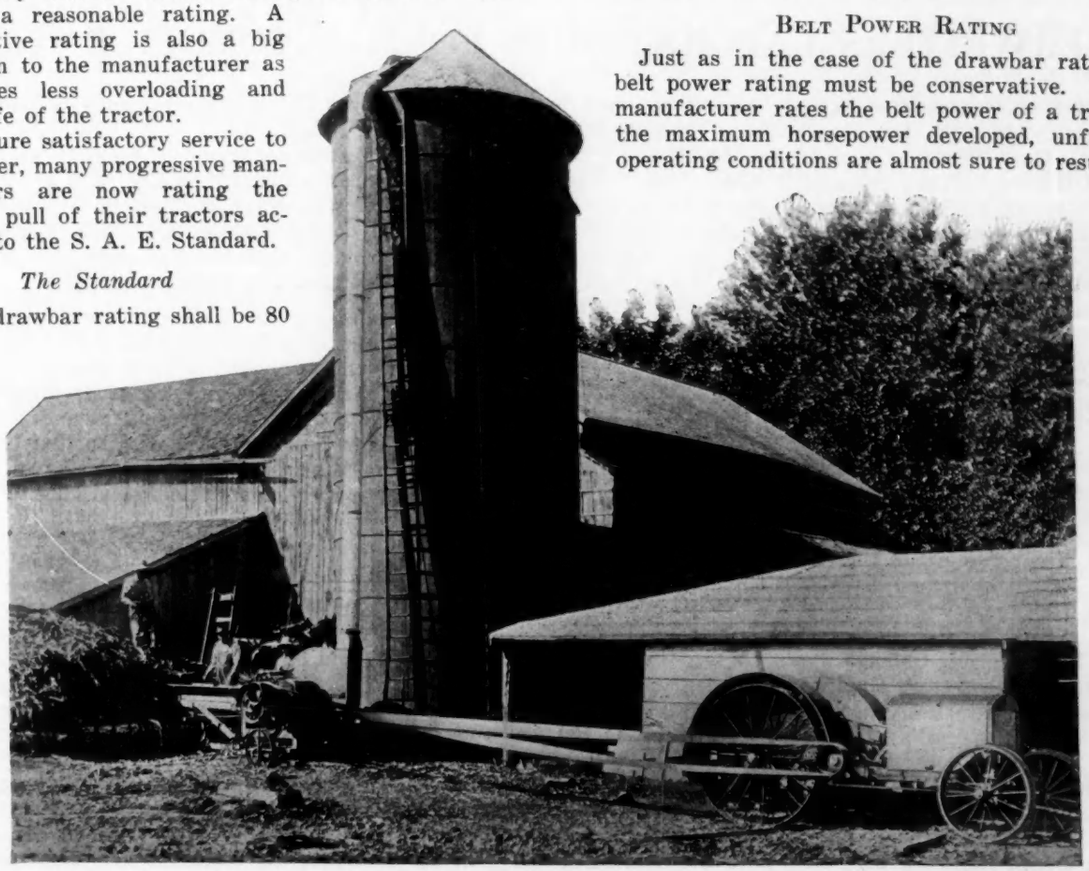
The Standard

"The drawbar rating shall be 80 per cent of the horsepower that the tractor is guaranteed to develop at the drawbar continuously for two hours, the tractor being in good condition and properly operated at rated engine speed. The test should be taken on ground sufficiently firm to give the traction wheels a good footing, a firm sod being preferable."

Standard, Conservative Drawbar Rating Provides a Definite Basis for Operating Tractors

Belt Power Rating

Just as in the case of the drawbar rating, the belt power rating must be conservative. When a manufacturer rates the belt power of a tractor at the maximum horsepower developed, unfavorable operating conditions are almost sure to result.



Uniform Belt Speed and Power Rating of Tractors Facilitate Connection with Farm Machinery, Render Throttling Unnecessary and Minimize Belt Difficulties

When the farmer hitches up a corn sheller, silo filler or feed grinder which requires, say, 10 hp. to an engine rated according to its maximum output of 10 hp. he finds that the combination does not work well. He says that the implement takes too much power or the engine is weak and discredits the manufacturers of both, whereas the whole trouble is due to the use of an incorrect belt power rating.

These are some of the reasons why so many tractor makers are turning to the S. A. E. standard belt power rating, which practically eliminates such difficulties and saves time and money for both manufacturers and farmers.

The Standard

"The belt power rating shall be 80 per cent of the horsepower the engine is guaranteed to deliver at the belt pulley continuously for two hours, the engine being in good condition and properly operated at rated speed."

BELT SPEED AND PULLEY WIDTH

The belt speeds in use for driving farm machines vary between 2000 and 3400 ft. per minute. This means that every time the farmer buys a belt-driven implement, or maybe borrows one from his neighbor, he must be very careful to see that the pulley is right or the belt speed changed to agree with his tractor. With a standard belt speed he can interchange all machines without bother and also have the assurance that they will be driven at the speed recommended by the manufacturer.

Careful investigation has enabled the Tractor Division of the S. A. E. to evolve a standard belt speed and the correct pulley and belt widths for tractors of different capacities. These standards, which were developed by the combined efforts of the leading tractor and farm implement engineers of the United States, represent the best practice.

The Standards

"Tractors shall be equipped with pulleys giving a belt speed of 2600 ft. per min. at the crown of the pulley. The pulleys shall be as large as possible, and the widths vary according to the horsepower delivered, as shown in the following table:

Horsepower	*Pulley Widths, in.*	*Max. Belt Widths, in.*
Under 20	6½	6
20 to 30	7½	7
Above 30		To be determined

"It is intended that the maximum belt widths shall be ½ in. less than the pulley widths."

There are about 250 S. A. E. standards pertaining to all branches of the automotive industries, developed by the cooperation of the leading manufacturing engineers. The Standards Department of the Society will gladly supply information covering any of this work and will furnish, at nominal cost, reprints of Standards and Recommended Practices.

UNDERWRITERS' LABORATORIES FORM AUTOMOBILE COUNCIL

FROM time to time the Society has had occasion to communicate with the Underwriters' Laboratories, 207 East Ohio Street, Chicago, mainly through different Divisions of the Standards Committee. Many members of the Society have been interested in the investigation of locking devices made by the Laboratories. Most of these locks are accessories, so that their use depends upon the operator of the car. It is said that on some makes of passenger car, transmission locks are standard equipment. These are integral parts of the machine and are considered an improvement, as regards theft protection, over the type that can be removed from the car.

Early in August, a committee to be known as the Automobile Council, was organized at the Underwriters' Laboratories in Chicago. The Council consists of three members of the Laboratories staff and five technical experts connected with companies issuing automobile insurance. The personnel of the Council is as follows:

W. H. Merrill, chairman, President Underwriters' Laboratories, Chicago.

A. R. Small, vice-chairman, Vice-president Underwriters' Laboratories, Chicago.

J. I. Banash, secretary, Engineer Casualty Dept., Underwriters' Laboratories, Chicago.

F. D. Bennett, special agent, Queen Insurance Co., 100 Milk St., Boston.

T. A. Kruse, Automobile Dept., Indemnity Mutual Marine Insurance Co., 5 So. William St., New York.

C. S. Timberlake, general agent, Marine and Transportation Dept., Hartford Fire Insurance Co., Hartford, Conn.

Samuel Tupper, Jr., assistant manager, Queen Insurance Company, Atlanta, Ga.

J. D. Vail, assistant general agent, Western Dept., Hartford Insurance Inc., 39 So. La Salle St., Chicago.

The Council will make a scientific study of all the factors in car construction or operation that may affect fire hazard, accident prevention or protection from theft. This study will have two main purposes:

(1) To establish a new method of classifying cars and trucks, based on the actual risk involved in the construction of each vehicle, instead of as at present having this depend upon the list price and engine horsepower.

(2) To collect data on fire, accident and theft occurrence for a large number of vehicles, so that the classification based on the constructional analysis can be refined by knowledge gained from actual experience.

New Rate Scheme Proposed

Many underwriters feel that the present scheme of establishing rates is unsound. They believe that each make of car should have a rate based on its own particular hazard. With such a system any form of automobile insurance could be sold at a definite rate per $100 of risk assumed. This would of course follow present practice with buildings on which the rate is based on the construction, protection and occupancy of the particular structure insured.

Before such a method of classification can be used, it will be necessary to establish arbitrary values for hazards. Suppose a certain model of car is put in the

100 per cent class in each hazard—fire, accident and theft. This model would be entitled to a certain rate for each $100 of insurance carried by its owner. Another car might be considered as entitled to an 80 per cent classification for the fire, 90 per cent for the accident and 100 per cent for the theft hazard. The second car would be given a high rate, since its construction is considered such as to make it a poorer risk. Similarly, every model of car on the market should be classified according to its particular hazard.

In determining this new classification, the Automobile Council proposes to separate each hazard into constituents. Fire protection, for example, will be considered as it is affected by the fuel, electrical and exhaust systems. In the fuel system the tank, piping, and carbureter will be studied, their construction and location being considered.

The analysis as regards accident protection would cover the strength and durability of important parts.

For theft protection the design and application of locks would be considered, both for vehicles now in use and for future production.

It is believed by the underwriters that by thus analyzing the problems a scheme of classification can be worked out that will have two advantages, (1) it will be more equitable than the one now in use; and (2) it will encourage advanced construction of passenger cars and trucks. The second advantage is the one of primary interest to members of the Society. The underwriters' committee recognizes their interest in the matter and intends, just as soon as a concrete scheme has been evolved, to call on the engineers and others manufacturing vehicles for their cooperation, so that the classification scheme will be of maximum service to all interested. The exact method by which this cooperation will be effected has not been worked out; it is possible, however, that some committee of the Society can be formed to advise the Underwriters' Committee on questions of an engineering nature.

The Society participation in the work is entirely in the future, since no action of any kind has been taken. Such action will naturally depend upon the opportunity cooperation with the underwriters offers to promote the object of the Society.

The Underwriters' Laboratories are at present cooperating with a number of other organizations of a public nature, the American Institute of Electrical Engineers and the American Institute of Architects being examples. Both these bodies have appointed special committees to work with the Laboratories, which are also in close touch with the Federal Bureau of Standards and Bureau of Mines.

Objects of the Laboratories

The Laboratories were founded in 1901 by the National Board of Fire Underwriters and are still operated and maintained by that organization. They carry out their object by (1) testing devices and appliances as submitted by manufacturers, in order to determine their merits in respect to life and fire hazard and accident prevention; and (2) reporting the results of such tests (when favorable) to insurance companies, public officials and others interested. A large laboratory is maintained in Chicago with facilities for making all sorts of mechanical, electrical and chemical tests and with furnaces where actual fire tests can be conducted. In New York a branch office is maintained, this being equipped to make tests and examinations of electrical devices. Branch offices are located in all the principal cities of this country and Canada.

In addition to the Automobile Council, the Laboratories have in operation Fire, Casualty and Electrical Councils. All of these consist in part of members of the Laboratories' organization, but the majority of the members are representatives of insurance organizations. These Councils are composed of men with broad experience, who can help the regular Laboratories' force to carry out the aim of its founders, "to secure the best and fairest opinion regarding the merits or demerits of every device, system, machine or material, in respect to life and fire hazards, and accident prevention, and to have the work so conducted and reviewed as to secure accuracy and uniformity in its findings." As a still further step in securing accuracy and fairness, conferences are held between members of the Laboratories' staff and representative committees of manufacturers. In these, examinations and test methods are discussed and the views of the industries as a whole secured on the Laboratories' activities.

COMMISSION FOR SCREW THREAD STANDARDIZATION

IN the May issue (page 449) details were given of a bill to appoint a commission for standardizing screw threads. The bill has now become a law, although in somewhat altered form. The number of commissioners has been increased from five to nine, the representation of the Army, the Navy, the American Society of Mechanical Engineers and the Society of Automotive Engineers having been doubled. The Commission now includes the director of the Bureau of Standards as chairman; two commissioned officers of the Army, to be appointed by the Secretary of War; two commissioned officers of the Navy, to be appointed by the Secretary of the Navy; and four to be appointed by the Secretary of Commerce, two of whom shall be chosen from nominations made by the American Society of Mechanical Engineers and two by the Society of Automotive Engineers. Another important change is the section providing that the Commission shall terminate at the end of six months, this period having been specified as one year originally. The Council of the Society has designated Edwin H. Ehrman, secretary-treasurer of the Chicago Screw Company, and H. T. Herr, vice-president of the Westinghouse Elec. & Mfg. Company, to act as the Society representatives on the Commission. It is understood that the representatives of the American Society of Mechanical Engineers will be James Hartness and Frank O. Wells, both of whom are also members of the Society of Automotive Engineers.

METROPOLITAN SECTION OUTING

ABOUT one hundred and twenty-five members of the Metropolitan Section and their friends made the trip on Aug. 4th to Camp John Pershing, Rockland Lake, N. Y. This is a private military training camp for boys twelve to eighteen years of age, about three hundred being in training at present. Four West Point cadets are acting as battalion commanders, and a fifth as colonel and commandant.

Most of the party went by automobile, arriving before midday dinner in time for a general get-acquainted party and a baseball game with a team from the camp.

The score was four to two against the Metropolitan Section, but, considering their lack of previous practice, the work of the engineers was remarkable.

In the afternoon a number of events were held. Mrs. F. E. Queeney won the ladies' automobile race, with Mrs. C. F. Scott second.

The ladies' 50-yard dash was won by Mrs. Scott, with Mrs. F. S. Duesenberg second. A special prize was awarded to Miss Norma Downe, who emerged from the race "a casualty" and had to be sent to the camp hospital for treatment. But for her mishap, the judges thought she might have been placed.

The potato race for ladies was won by Mrs. A. Poole, with Mrs. P. M. Heldt and Mrs. Mears tied for second.

The men's regatta, with ten entries, brought forth some excellent rowing. The course was up the lake to windward and return. First place was tied between William S. Howard and H. W. Slauson, with H. C. Gibson pulling a close third.

In the men's bowling contest, with ten entries, high score was rolled by J. O. Hobby, with H. D. Dabney second.

A feature of the afternoon was the formation of 32 of the ladies into four squads, which were taught the principles of close-order drill by the four West Pointers. The excellent appearance and well organized discipline of these squads was a revelation. Untimely rain prevented the special parade and drill arranged for the camp force.

The only unfortunate event of the day occurred when a member, F. E. Queeney, was caught by the guard red-handed with a bottle of "intoxicants," in violation of camp regulations. He was summarily court-martialed, and, although he was found guilty by a hastily impanelled jury of ladies, fortunately he was released on suspended sentence by Provost Marshal Mrs. Lila Ross.

Ethelbert Favary was chairman of the committee in charge, and the judges were E. E. La Schum, A. C. Bergmann, N. B. Pope, F. S. Duesenberg and C. F. Scott.

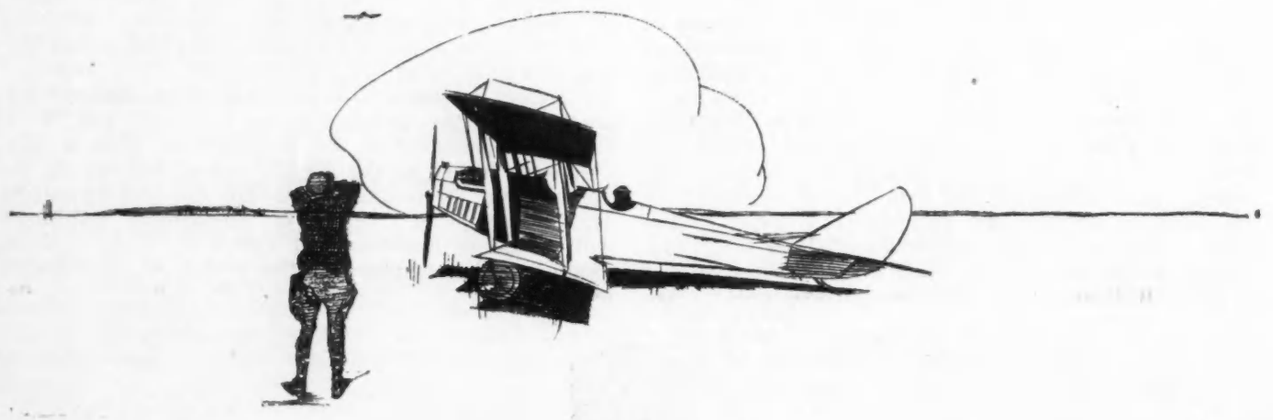
Prizes consisting of War Savings Stamps were donated by the following companies: Auto Supply Co., Chevrolet Motor Co., Goodrich Tire Co., Kelly-Springfield Tire & Rubber Co., *Leslie's Weekly*, Standards Parts Co., Splitdorf Electrical Co., Sprague Electric Co., U. S. Tire & Rubber Co.

MR. FUNK BECOMES A SECOND VICE-PRESIDENT

AT a recent meeting of the Council, T. B. Funk, manager of the Tractor Branch of the Moline Plow Company, was elected second vice-president of the Society, representing tractor engineering, in place of Capt. Dent Parrett, who resigned this office on entering the military service.

Mr. Funk is one of the pioneer tractor engineers of the country, having been connected in the early days as general manager and engineer with the Universal Tractor Company of Newcastle, Ind., and later with the Universal Tractor Manufacturing Company of Columbus, Ohio. Since 1915, however, he has been with the Moline Company.

He has spent a number of years in the automobile business, at one time being sales manager of the Marion Automobile Company of Indianapolis. He was elected a Member of the Society Sept. 2, 1916, and is now a member of the Membership Committee.



PERSONAL NOTES OF THE MEMBERS

Frank H. Ball, formerly engineer with the Penberthy Injector Co. of Detroit, is now manager of the carbureter department of the company.

George R. Beamer, branch manager, U. S. Gauge Co., New York, is now with the same company in Detroit.

Vincent Bendix, formerly with the Eclipse Machine Co., Elmira, N. Y., and Brandenburg & Co. of Chicago, is now with the Eclipse-Bendix Drive in Chicago.

Emil Jules Beuret, formerly with the Packard Motor Car Co. of New York at Paterson, N. J., is no longer connected with the company.

J. Cermak, formerly chief engineer and superintendent, the H. G. Burford Co. of Fremont, Ohio, is now with the Winton Co. of Cleveland.

H. W. Christensen, formerly with the Lincoln Motor Co., Detroit, is now doing truck engineering with the Packard Motor Car Co. of Detroit.

George Cormack, formerly master mechanic, Appleton Mfg. Co., Batavia, Ill., is now works manager of the H. C. Doman Co., Oshkosh, Wis.

Robert F. Dyer, formerly assistant general sales manager, the Aluminum Castings Co., Detroit, is now with the Parish Mfg. Co. of Detroit.

Bert B. Fornaciari, formerly secretary and general manager, Harvey Motor Truck Co., Harvey, Ill., is now manager and chief engineer, Midland Motor Car & Truck Co. of Oklahoma City, Okla.

M. W. Hanks, formerly Standards Manager of the Society, is now aeronautical mechanical engineer, Bureau of Construction and Repair, U. S. Navy, Washington, D. C.

K. L. Hermann, formerly in Detroit, is now superintendent of motor truck division, Studebaker Corp. of America in South Bend, Ind.

Horace G. Hobbs, formerly engineer with Anderson Motor Co. of Rock Hill, S. C., is now with the same company in Detroit.

A. Krieg, formerly chief engineer, Emerson-Brantingham Co., Minneapolis, is now chief engineer of tractor department, the Pan Motor Co. of St. Cloud, Minn.

Grover C. Loening has recently completed the design of a two-seater battleplane of the monoplane type. This machine, equipped with a 300-hp. Wright-Martin engine, was tested on the Army Field at Mineola early in August. On the test the machine is said to have shown a low landing speed and great stability. It is constructed so that the pilot has a practically unlimited range of vision, and the gunner practically no blind spot. The construction is of such simple design that less than one-tenth the number of parts in the ordinary machine are used.

D. McKenzie, formerly general superintendent, Falls Motors Co., Sheboygan Falls, Wis., is now superintendent of production, Winslow Brothers of Chicago.

J. C. Manternach, formerly manager, Rim and Tube Division, Standard Parts Co. of Cleveland, is now president of the American Welding & Mfg. Co. of Warren, Ohio.

C. L. Ott, formerly engineer, Ott Grinder Co., Indianapolis, is now mechanical engineer, Albert J. Ott, 32 N. Clinton St., Chicago.

Charles B. Page, formerly works manager, Duesenberg Motors Corp., Elizabeth, N. J., has now opened an office as automotive engineer at 72 W. Adams Street, Chicago.

Clark W. Parker, formerly engineer, Cadillac Motor Co. of Detroit, is now a consulting engineer in New York.

Frank E. Queeney, formerly engineer, General Vehicle Co., Inc., Long Island City, is now with the Walker Vehicle Co. of Long Island City, N. Y.

Willard F. Rockwell, formerly factory manager and consulting engineer, the Torbenson Axle Co., Cleveland, is now factory manager and assistant general manager of the same company.

Charles M. Schwab, formerly production engineer, Aeronautical Engine Corp., Long Island City, is now special buyer, Wright-Martin Aircraft Corp. of Long Island City, N. Y.

Ellis W. Templin, formerly assistant chief engineer, Selden Motor Vehicle Co., Rochester, N. Y., is now with the Bessemer Motor Truck Co. of Grove City, Pa.

A. G. Thomson, formerly sales manager, Auto Lubricants Department, Joseph Dixon Crucible Co. in Jersey City, N. J., is now general manager and partner, New York Auto Wrecking Co. of New York.

H. R. Van Deventer, formerly with the Sumter Works of the Splitdorf Electrical Co. in Sumter, S. C., is now with this company in Newark, N. J.

Harold S. White, formerly student, Armour Institute of Technology, Chicago, is now altitude laboratory assistant with the Bureau of Standards in Washington, D. C.

M. G. White, formerly sales manager, U. S. Ball Bearing Mfg. Co. in Chicago, is now manager of the Cincinnati office at 1814 First National Bank Bldg., Cincinnati.

Z. T. Wong, formerly student at Massachusetts Institute of Technology, Cambridge, is now engineer in the experimental department, the Standard Aircraft Corp. of Elizabeth, N. J.

L. R. Wottring, formerly chief engineer, Houghton Motor Car Co., Marion, Ind., is now assistant chief inspector, Airplane Engine Division, Nordyke & Marmon Co. of Indianapolis.

CECIL NORMAN BARKER

Lieutenant C. N. Barker died in France about a month ago of injuries and burns received in his blazing airplane.

Lieutenant Barker was born in Durham, England, July 25, 1897, and went to Canada with his family when very young. He was educated in the public schools, passing to technical school where he was trained as a draftsman. He then joined the National Steel Car Company of Hamilton, specializing on motor-truck layouts. He entered the service in Hamilton, joining the Royal Flying Corps in September, 1917. He was in training camps in Toronto and Texas, and crossed to France in March of this year.

His detail there was to fly new machines from the base of supplies to the firing line.

Lieutenant Barker was admitted to the Society on May 20, 1916, as a Junior Member.

GORDON W. COOPER

Gordon W. Cooper was killed in an airplane accident which occurred June 13, 1918, at Barron Field, Fort Worth, Texas. Mr. Cooper was born July 13, 1894, in Lansing, Mich., his home at the time of his death. At the time he entered the service Mr. Cooper was a student in the engineering department of the Michigan Agricultural College, East Lansing. He was admitted to the Society May 14, 1917, as an Enrolled Student.

Honor Roll of Society Members

THE following members have recently entered the services of the government in civilian or military capacities. This list, together with the "Service Directory of Members" following, is intended to contain the names of all members connected with the government, either in the military service or in civilian capacities. The names are listed in two parts, the first showing the members who have actually entered the military services, and the second those engaged as civilians. Every effort is made to have the addresses correct. It is therefore requested, in case of any error, that the member concerned immediately inform the New York office of the Society, so that proper correction can be made. Members who have actually entered the service in any capacity, and who are not listed, should also write the details to the New York office.

MILITARY HONOR ROLL

Adams, Ralph, first lieutenant, Engineering Branch, Motor Transport Service, Quartermaster Corps, N. A., Washington.

Boedecker, Kenneth J., chief machinist mate, Barracks 315, U. S. N. R. F., League Island Navy Yard, Philadelphia.

Bridge, Robert B., engineer officer, 217th Squadron Air Service, U. S. R., Mitchell Field, Long Island, N. Y.

Bubna, R. C., second lieutenant, designer, Engineering Division, Motor Transport Division, Quartermaster Corps, N. A., (mail), Militor Corp., Jersey City, N. J.

Cervenka, John A., captain, commander of casuals, Quartermaster Corps, N. A., Camp Meigs, Washington.

Crowhurst, H. W., lieutenant, experimental laboratory research assistant, Engineering Section, Motors Division, Quartermaster Corps, N. A., Camp Holabird, Colgate Creek, Md.

Fliedner, Carlyle S., ensign, Aviation Section, U. S. N. R. F., Bureau of Navigation, Washington.

George, Edwin S., colonel, Group F, Wing 7, Procurement Division, Motor Transport Service, N. A., Seventh and B Streets, Washington.

Hoyt, Fred A., sergeant, 30th Co., 8th Battalion, Camp Upton, Long Island, N. Y.

Hyde, C. M., private, inspector of motor transport equipment, Quartermaster Corps, U. S. A., Washington.

Iago, Norman John, private, Co. E, 8th Division, M. S. Train, Camp Holabird, Md.

Kroeger, F. C., captain, Engineering Section, Motor Transport Service, Quartermaster Corps, N. A., Washington.

Kuenzel, S. H. Hunter, private, Supply Co., 70th Artillery, Coast Artillery Corps, A. E. F.

Mann, Arthur S., Sanitary Division, Medical Corps, N. A., Kankakee, Ill.

Minturn, H. A., chief special mechanic, Aviation Division, U. S. N. R. F., Washington.

Mummert, A. J., ensign, operative duties, U. S. Naval Flying Corps, Washington.

Oehler, Edward A., private, Motor School, Camp Holabird, Baltimore, Md.

Parker, Victor C., major, 3rd Motor Mechanics Regiment, Aviation Section, Signal Reserve Corps, A. E. F., France.

Radack, Harry E., second lieutenant, Motor Transport Division, Quartermaster Corps, N. A., Washington.

Rowe, Samuel S., sergeant, 821st Aero Squadron, Speedway, Ind.

Sandt, A. R., sergeant, leading draftsman on trucks, Motor Equipment Section, Engineering Bureau, O. D., U. S. A., (mail) Government Engineering Department, Maxwell Plant, Chalmers Motor Co., Detroit.

Vohrer, W. R., second lieutenant, draftsman, Motor Transport Service, Quartermaster Corps, N. A., Washington.

Walker, Karl F., first lieutenant, automotive engineer, Motor Transportation Division, Quartermaster Corps, N. A., Camp Holabird, Md.

White, Thomas H., lieutenant, officer in charge of land and water transportation, Aeronautical Experimental Station, Langley Field, Hampton, Va.

CIVILIAN HONOR ROLL

Churchward, Alexander, vice-chairman of Electric Welding Committee, U. S. Shipping Board, Washington, at New York City.

Faber, Charles J., designer, Airplane Engineering Department, Bureau of Aircraft Production (mail) Fergus Motors of America, Inc., 370 Jelliff Ave., Newark, N. J.

Fuller, C. T., inspector of engineering drawings, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia.

Gibbs, S. E., instructor in engine department, U. S. School of Military Aeronautics, University of Illinois, Urbana.

Harkness, E. L., senior inspector of airplanes and airplane engines, Bureau of Aircraft Production, 480 Lexington Ave., New York City.

Hitchcock, Ralph, Signal Service Aircraft Bureau, Washington.

Johnson, Frederick H., inspector of airplanes, Bureau of Construction and Repair, U. S. Navy (mail) Gallaudet Aircraft Corp., E. Greenwich, R. I.

Johnston, W. S., engineering department, Naval Aircraft Factory, Navy Yard, Philadelphia.

King, Charles B., aeronautical mechanical engineer, Aviation Section, Signal Corps (mail) Duesenberg Motors Corp., Elizabeth, N. J.

Madison, R. D., chief draftsman, Motor Equipment Section, Ordnance Engineering Bureau, Indianapolis.

Meredith, G. W., senior inspector of airplanes and airplane engines, Bureau of Aircraft Production, Plant 17, Fisher Body Corp., Detroit.

Moorhouse, A., executive research engineer, Airplane Engineering Department, Bureau of Aircraft Production, Mutual Home Bldg., Dayton.

Morgan, E. Tasso, senior inspector of airplanes and airplane engines, Signal Service at Large, Breese Aircraft Co., Farmingdale, Long Island, N. Y.

Norton, F. H., aeronautical engineer, Bureau of Aircraft Production, Mass. Inst. of Tech., Cambridge, Mass.

Ober, Shatswell, aeronautical engineer, Airplane Engineering Department, Bureau of Aircraft Production, Mass. Inst. of Tech., Cambridge, Mass.

Pomeroy, G. M., aeronautical mechanical engineer, Naval Aircraft Factory, Navy Yard, Philadelphia.

Puff, Michael J., designer, Airplane Engineering Department, Bureau of Aircraft Production, (mail) Fergus Motors Co., 370 Jelliff Ave., Newark, N. J.

Quinn, W. J., laboratory assistant, Engineering

Branch, Motor Transport Section, Quartermaster Corps, Washington.

Rounds, E. Wadsworth, instructor in aeronautics, U. S. N. R. F., U. S. Naval Aviation Detachment, Cambridge, Mass.

Wahl, G. Adolph, 34 P. O. D., Camp Hancock, Ga.

Yackey, Carl H., chief inspector, Detroit district, Motor Transport Section, Quartermaster Corps, U. S. A., Washington.

Zeitler, Raymond S., Engineering Section, Motor Transport Division, Quartermaster Corps, (mail) Major Kalb, 358 Union Station, Washington.

Service Directory of Members

Military Service

ALDEN, HERBERT W., lieutenant-colonel, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

ALDRIN, EDWIN E., lieutenant, Coast Artillery Corps, U. S. A., *Ft. McKinley, Maine.*

ALTER, ARTHUR S., chief machinist's mate, U. S. N. R. F., *Washington.*

AMON, CARL H., first lieutenant, Aviation Section, Signal R. C., 1st Motor Mechanics' Regiment, A. E. F., *France.*

ANDERSON, E. S., lieutenant, Aviation Section, Signal Corps, U. S. A., Rockwell Field, *San Diego, Cal.*

ANDERSON, OSCAR G., private, Co. A, 1st Prov. Ordnance Depot Battalion, U. S. A., (mail) P. O. No. 713, A. E. F.

ANDERSON, WILLIAM C., lieutenant, Engineer R. C., *Brooklyn, N. Y.*

ARNOLD, BION J., lieutenant colonel, Aviation Section, Signal R. C., *Washington.*

BAKER, FRANCIS H., chief machinist's mate, U. S. N. R. F., U. S. Naval Gas Engine School, Columbia University, *New York.*

BARE, ERWIN L., first lieutenant, Military Truck Production Section, Quartermaster Corps, U. S. N. A., 358 Union Station, *Washington.*

BARKER, C., pilot cadet, Royal Flying Corps, *Canada.*

BARNABY, R. S., ensign, U. S. N. R. F., *Buffalo,* assigned to inspection duty.

BARNES, NEVIN C., cadet, U. S. School of Military Aeronautics, *Princeton, N. J.*

BARTON, W. E., first lieutenant, Quartermaster R. C., *Washington.*

BATES, WM. O., JR., first lieutenant, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

BEDFORD, E. A., U. S. A., A. E. F., *France.*

BENJAMIN, DAVID, Co. A, Training Detachment, *Valparaiso, Ind.*

BEVIN, SYDNEY B., captain, Engineering Bureau, Motor Equipment Section, Ordnance Department, U. S. R., *Washington.*

BIBB, JOHN T., JR., lieutenant, Aviation Section, S. R. C., Payne Field, *W. Point, Miss.*

BIGELOW, A. C., second lieutenant, Motor Transport Section, Quartermaster Corps, U. S. A., 205 Union Station, *Washington.*

BILLINGS, C. M., first lieutenant, Motor Equipment Section, Engineering Bureau, office of Chief of Ordnance, 448 N. Capitol Ave., *Indianapolis.*

BLAIR, C. A., corporal, 472d Aero Squadron, A. E. F., *France.*

BLANK, M. H., first lieutenant, Motor Equipment Division, Ordnance R. C., Grant Motor Car Co., *Cleveland.*

BLEAKLEY, P. A., sergeant, Ordnance Motor Instruction School, Holt Mfg. Co., *Peoria, Ill.*

BRINTON, BRADFORD, major, Quartermaster Corps, U. S. A., *Washington.*

BLOOD, HOWARD E., captain, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio,* assigned as business executive, Airplane Engineering Department.

BOGGS, GEO. A., lieutenant, Quartermaster Corps, U. S. A.; (mail) Farmers Loan & Trust Co., *Paris, France.*

BOWEN, C. H., captain, Military Truck Production Section, Office of Quartermaster General, *Washington.*

BRANDMEIER, F. M., Signal Corps, U. S. A., Motor Transport School, Wilbur Wright Field, *Fairfield, Ohio.*

BRISCOE, FRANK, captain, Signal Corps, U. S. A., *France.*

BRITTEN, DANIEL L., captain, Ordnance R. C., *Washington,* assigned to Gun Division, Ordnance Section.

BRITTON, WM. M., major, engineer of motor transportation, Quartermaster R. C., *Washington.*

BRODIE, JAMES S., Engineer Corps, U. S. N. A., *Washington.*

BROWN, HAROLD HASKELL, first lieutenant, Coast Artillery Corps, U. S. N. A., *Fort Totten, N. Y.*

BROWNE, ARTHUR B., major, Sanitary Corps, U. S. N. A., (mail) General Motors Co., *Detroit.*

CALLAN, JOHN LANSING, lieutenant, Reserve Flying Corps, U. S. N., U. S. S. Seattle, (mail) Postmaster, *New York.*

CAMPBELL, ARCHIBALD F., cadet, U. S. School of Military Aeronautics, Barracks 2, *Urbana, Ill.*

CAMPBELL, LINDSEY F., 4th Battery, 2d P. T. R., *Fort Sheridan, Ill.*

CHASE, A. M., major, Ordnance Department, U. S. A., *Washington.*

CHURCHWARD, A. GRAY, second lieutenant, Third Motor Mechanics Regiment, Signal Corps, A. E. F.

CLARK, EDWARD L., first lieutenant, Signal R. C., McCook Field, *Dayton, Ohio.*

CLARK, ELMER J., captain, Plant Facilities Dept., Bureau of Aircraft Production, *Washington.*

CLARK, VIRGINIUS E., lieutenant colonel, Signal Corps, U. S. A., *Washington*

CLARKE, A. FIELDER, Ground School, Aviation Section, U. S. N., *Washington.*

CLEAVER, CHARLES F., captain, A. S. C., British War Department, London, Eng., assigned as inspector of mechanical transport, (mail) Peerless Motor Car Co., *Cleveland.*

COCKRILL, EMMET, first lieutenant, Ordnance R. C., Ford Motor Co., *Highland Park, Mich.,* assigned as production officer and mechanical engineer.

COE, EDW. M., first lieutenant, Quartermaster Corps, U. S. A., *Washington,* (mail) Mechanical Repair Shops No. 302, A. E. F., *France.*

COFFMAN, DON M., first lieutenant, Aviation Section, Signal R. C., Commercial Bldg., *Dayton, Ohio.*

COLLINS, KENNETH G., first lieutenant, Signal R. C., A. E. F., *Italy,* (mail) 8th Aviation Instruction Center.

COMSTOCK, HERBERT F., second lieutenant, Aviation Section, U. S. Air Service, A. P. O. 738, A. E. F., via *New York.*

DAHLQUIST, CHAS. S., major, Quartermaster Department, U. S. N. A., *Washington,* assigned to Motors Division as supervisor of inspection on standardized military trucks.

DAYTON, WILLIAM E., sergeant, 306th Regiment, Field Artillery, U. S. N. A., *France.*

DEE, SIMON R., private, Ordnance Motor Instruction School, Raritan Arsenal, *Metuchen, N. J.*

DEEDS, EDWARD A., colonel, Equipment Division, Signal Corps, U. S. A., State, War and Navy Bldg., *Washington.*

DE LA GARDE, LOUIS A. C., lieutenant, Motor Transport Army Service Corps, *Chiswick, London, England,* assigned as first-class engineer and workshops officer.

DE LORENZI, ERNEST A., officer, Mechanical Transport, War Department, *London, Eng.*

DENISON, ARTHUR H., second lieutenant, Aviation Section, Sig. R. C., Hazelhurst Field, *Mineola, L. I., N. Y.*

DE WITT, GEORGE W., ensign, U. S. N., *France,* (mail) U. S. S. Utowana, Postmaster, *New York.*

DIAMOND, JAMES E., captain, Ordnance R. C., assigned to Motor Instruction School, *Kenosha, Wis.*

DICKEY, HERBERT L., captain, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

DIMOND, G. A., first lieutenant, Motor Section, Ordnance R. C., Ft. Herring, *Peoria, Ill.*

DOST, CHARLES O., first lieutenant, Aviation Section, Signal Corps, U. S. A., Ellington Field, *Houston, Texas,* assigned to engineering department.

DU BOSE, GEO. W. P., major, American Ordnance Base Depot, A. E. F., *France.*

DUNCAN, A. C., first lieutenant, Balloon Co. No. 7, Signal Corps, Aviation Section, Signal R. C., (mail) A. E. F., *France.*

DUNTLEY, LLOYD B., first lieutenant, Ordnance R. C., *Washington,* assigned to Engineering Motor Equipment Section.

EARLE, LAWRENCE H., captain, Ordnance R. C., assigned as inspector of ordnance, Holt Mfg. Co., *Peoria, Ill.*

EELLS, PAUL W., lieutenant, 330th Field Artillery, Artillery R. C., Camp Custer, *Battle Creek, Mich.*

EGGEN, O. E., 337th Field Artillery, Ordnance Corps, U. S. A., *Camp Dodge, Iowa.*

EHLERS, PAUL, Battery E, 304th Field Artillery, U. S. A., A. E. F., *France.*

ENGESSER, BENJ. M., School of Military Aeronautics, Massachusetts Institute of Technology, *Cambridge, Mass.*

ENGLISH, G. H., JR., first lieutenant, Ordnance R. C., *Washington.*

EVANS, GORDON M., captain, Engineering Bureau, Motor Equipment Section, Ordnance Department, U. S. R., *Washington.*

FARRELL, MATTHEW, captain, Quartermaster R. C., *Washington.*

FINKENSTAEDT, EDWARD R., captain, Military Truck Production Section, Office of Quartermaster General, *Washington.*

FISHLEIGH, W. T., major, Sanitary Corps, U. S. N. A., *Washington,* assigned as automobile engineer.

FITZGERALD, GERALD, second lieutenant, Motor Truck Co. 348, *Camp McArthur, Texas.*

FLANIGAN, E. B., Officers' Reserve Training Camp, *Plattsburg, N. Y.*

FORRER, J. D., captain, Engineer R. C., *Washington.*

FOSS, CLARENCE M., captain, Ordnance R. C., Rock Island Arsenal, *Rock Island, Ill.,* assigned to Motor Section.

FOSTER, WILLIAM J., second lieutenant, Signal R. C., U. S. A., *Washington,* assigned to Engine Design Section, Airplane Engineering Department, Aviation Section.

FOX, RUDOLPH H., first lieutenant, Ordnance R. C., *Washington.*

FRANKLIN, G. KING, captain, Motor Section, Ordnance R. C., *Washington.*

FREDRICKSEN, ARTHUR, first-class machinist's mate, Aviation Section, U. S. Navy, Camp Perry, *Great Lakes, Ill.*

FREHSE, A. W., captain, Engineering Section, Motor Transport Service, Quartermaster Corps, N. A., *Washington.*

FREVERT, CARL B., first lieutenant, Ordnance R. C., A. E. F., *France.*

FRIEDGEN, A. E., first lieutenant, Engineering Section, Motor Transport Service, Quartermaster Corps, *Washington.*

FULTON, RICHARD WALLACE, 5th Cadet Squadron, Aviation Section, Signal Corps, U. S. A., *Houston, Texas.*

FUNKEY, L. H., U. S. Naval Reserve Force (mail), Allis-Chalmers Mfg. Company, *Milwaukee.*

FURLOW, JAMES W., lieutenant colonel, Quartermaster Corps, U. S. A., *Washington,* assigned to Office of Quartermaster General.

GAEBELEIN, ARNO W., captain, Procurement Division, Artillery Section, Ordnance Department, N. A., Sixth and B Sts., *Washington.*

GARDNER, LESTER D., captain, commanding officer, Aviation Section Signal Corps Training Camp, *Camp MacArthur, Tex.*

GETSCHMAN, G. F., second lieutenant, Ordnance R. C., *Washington,* (mail) Office of Inspector of Ordnance, Maxwell Motor Co., Chalmers Plant, *Detroit.*

GEY, WILLIAM, 377th Truck Train, U. S. N. A., Camp Merritt, *Tenafly, N. J.*

GFRORER, A. H., first lieutenant, Ordnance R. C., assigned as production officer, Maxwell Motor Co., Chalmers Motor Car Co., *Detroit.*

GIBBS, S. E., U. S. School of Military Aeronautics, University of Illinois, *Champaign, Ill.*

GILLIS, HARRY A., major, Ordnance R. C., *Washington.*

GLOVER, FRED., colonel, Quartermaster Corps, U. S. A., *Washington,* in charge of Army Motor Transport Service.

GORRELL, EDGAR S., lieutenant colonel, Aviation Section, Signal Corps, U. S. A., Washington, (mail) Air Service, A. E. F., *France.*

GOULD, ALLEN A., captain, Inspection Section, Quartermaster Corps, N. A., *Washington.*

GRAHAM, LOUIS, captain, 309th Engineers, Engineers R. C., *Camp Leach, Washington.*

GRAY, SAMUEL W., first lieutenant, Aviation Section, Signal R. C., U. S. A., (mail) 4th Co., 2d Motor Mechanics Regiment, Air Service A. E. F., *France.*

GREEN, GEO. A., major, Tank Section, British E. F., *France.*

GUERNSEY, CHARLES, captain, Engineering Section, Motor Transport Service, Quartermaster Corps, U. S. N. A., *Washington.*

GUTHRIE, JAMES, major, Ordnance R. C., *Washington,* assigned to Carriage Division, Engineering Bureau.

HAESKE, F. C., lieutenant, U. S. A., Camp Sherman, *Chillicothe, Ohio.*

HALL, C. M., major, Aviation Section, Signal Corps, U. S. A., *Dayton, Ohio.*

HALL, ELBERT J., lieutenant colonel, Bureau of Aircraft Production, Lindsey Bldg., *Dayton.*

HALL, RICHARD H., JR., first lieutenant, Quartermaster Corps, U. S. N. A., *Washington.*

HARMS, HENRY W., lieutenant colonel, Aviation Section, Signal Corps, U. S. A., (mail) Base Section No. 3, *London, England.*

HARTMAN, A. A., private, U. S. N. A., Camp Devens, *Ayer, Mass.*

HAWKE, CLARENCE E., Aviation Section, Signal Corps, U. S. A., *Washington.*

HECKEL, C. E., second lieutenant, Motor Transport Division, Quartermaster Corps, *Washington.*

HECOX, F. C., major, Motor Transport Service, S. O. S., S. O. U., headquarters A. E. F., *France.*

HEGEMAN, HARRY A., lieutenant colonel, Motor Transport Repair Shops, U. S. A. P. O. 708, *France.*

HENDERSON, S. W., first lieutenant, Special Engineering, Ordnance Reserve Corps, Raritan Assembling Plant, *Metuchen, N. J.*

HICKS, HARLIE H., captain, Aviation Section, Signal R. C., *Washington.*

HOBBS, J. W., first lieutenant, Ordnance R. C., U. S. A., commanding officer, Fourth Heavy Mobile Ordnance Repair Shop, *Camp Hancock, Ga.*

HOFFMAN, ROSCOE C., captain, Carriage Division, Motor Equipment Section, Ordnance R. C., *Washington.*

HORINE, M. C., second lieutenant, Aviation Section, Signal R. C., *Washington.*

HORNER, LEONARD S., major, Equipment Division, Signal Corps, U. S. A., *Washington.*

HOWARD, WALTER S., first lieutenant, Military Truck Production Section, office of Quartermaster General, *Washington.*

HOWLAND, WM. I., JR., lieutenant, Bureau of Ordnance, Navy Department, U. S. N. R. F., *Washington.*

HOUSTON, HAROLD S., 3d Officers' Training Camp, *Fort Monroe, Va.*

HOYT, F. R., lieutenant, Aviation Section, Signal R. C., A. E. F., *France.*

HUBBELL, LINDLEY D., lieutenant colonel, U. S. N. A., Ordnance Department, *Springfield, Mass.,* assigned as Officer in Charge, Hill Shops, Springfield Armory.

HULL, M. LAIR, private, Production Division, Ordnance Department, N. A., (mail) Connersville Furniture Co., *Connersville, Ind.*

JACO, E. L., captain, Engineer R. C., U. S. A., *Washington,* assigned to General Engineering Depots.

JEFFREY, MAX L., first lieutenant, Military Truck Production Section, Office of Quartermaster General, *Washington.*

JENKS, WESTON M., U. S. N. R. F., Massachusetts Institute of Technology, *Cambridge, Mass.,* assigned as instructor in naval aviation.

JENNINGS, J. J., first lieutenant, Engineer R. C., Office of Chief Engineer, A. E. F., P. O. 717.

JONES, R. E., lieutenant, U. S. N. R. F., Washington, (mail) U. S. S. New York, Postmaster, *New York City.*

JOY, HENRY B., lieutenant colonel, 4th Motor Mechanics Regiment, Signal Corps, U. S. A., *Camp Hancock, Ga.*

JUNK, FRED H., second lieutenant, Aviation Section, Signal R. C., U. S. A., (mail) Signal Corps Aviation School, Carlstrom Field, *Arcadia, Florida.*

KALB, LEWIS P., major, Quartermaster Corps, U. S. N. A., *Washington.*

KENDRICK, JOHN F., Signal Corps, A. E. F., *France,* assigned to Research Inspection Division.

KENNEDY, H. H., captain, Ordnance Department, N. A., *Washington.*

KENT, RICHARD, Company B, 302d Battery, Tank Corps, Camp Colt, *Gettysburg, Pa.*

KINKEAD, R. S., sergeant, Third Reserve Officers' Training Corps, Field Artillery, *Washington.*

KISHLINE, FLOYD F., first lieutenant, Motor Transport Service, Quartermaster Corps, *Washington.*

KLEMIN, ALEXANDER, sergeant, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio;* assigned to research, Airplane Engineering Department, Aviation Section.

KLINE, H. J., first lieutenant, Ordnance R. C., *Washington,* assigned to Anti-Aircraft Section, Carriage Division.

KLOCKAU, W. F., private, Co. N, 4th Battalion, 163rd Depot Brigade, *Camp Dodge, Iowa.*

KOHR, ROBERT F., second lieutenant, Engineers R. C., *Washington.*

KOTTNAUER, EDWIN H., first lieutenant, inspector of ordnance, Ordnance R. C., U. S. A., (mail) Paige-Detroit Motor Car Co., *Detroit.*

LANDON, CHARLES H., second lieutenant, Aviation Section, Signal R. C., Camp Dick, *Dallas, Tex.*

LANE, ABBOTT A., first lieutenant, Aviation Section, Signal R. C., *Detroit, Mich.*

LANZA, MANFRED, major, Quartermaster Corps, U. S. A., 303rd Motor Supply Train, Camp Dix, *Wrightstown, N. J.*

LARSEN, LESTER REGINALD, second lieutenant, 107th Engineer Train, U. S. A., A. E. F., *France.*

LAVERY, GEORGE L., first lieutenant, Mobile Ordnance Repair Shop, 6th Division Ammunition Train, A. E. F. via *New York.*

LAY, ARTHUR J., captain, Aviation Section, Signal R. C., *Washington.*

LE FEVRE, W. G., lieutenant, 302d Ammunition Train, 77th Division, U. S. A., *France.*

LEOPOLD, JOSEPH, second lieutenant, Aviation Section, Signal Reserve Corps, U. S. A., Hazelhurst Field, *Mineola, Long Island, N. Y.*

LEVY, ALFRED K., 3rd Ordnance Corps, assigned to Motor Equipment Section, U. S. N. A., *Washington.*

LEWIS, CHARLES B., captain, Ordnance R. C., Camp Lewis, *American Lake, Wash.*

LEWIS, HARRY R., JR., captain, Ordnance R. C., Springfield Armory, *Springfield, Mass.*

LIBBEY, E. B., captain, 102nd Ammunition Train, 27th Division, U. S. A., *Spartanburg, S. C.*

LOEB, S. ARTHUR, lieutenant, Signal R. C., U. S. A., (mail) General Motors Corp., Buick Division, *Flint, Mich.*

LUDOLPH, F. E., Aviation Section, Signal Corps, U. S. A., Kelly Field No. 1, *S. San Antonio, Tex.*

MCCORMICK, BRADLEY T., captain, Ordnance Department, U. S. A., *New York.*

MACDONALD, K. B., lieutenant commander, U. S. N. R. F., Naval Aircraft Factory, League Island Navy Yard, *Philadelphia.*

MCGILL, GEO. E., Equipment Division, Aviation Section, Signal Corps, U. S. A., Packard Motor Car Co., *Detroit.*

MCINTYRE, H. C., captain, Ordnance R. C., *Washington.*

MCMURTRY, ALDEN L., captain, Quartermaster Corps, U. S. N. A., assigned to duty with War Plans Division, General Staff, War College, *Washington.*

MACKIE, MITCHELL, major, Quartermaster Corps, U. S. A., A. E. F., *France,* assigned to Motor Truck Transport Section.

MACCOULL, NEIL, JR., U. S. N. R., *Washington.*

MARMON, HOWARD, major, Airplane Engineering Division, Signal R. C., McCook Field, *Dayton, Ohio.*

MARSHALL, W. C., captain, Ordnance R. C., *Washington.*

MARTIN, KINGSLEY G., captain, Quartermaster R. C., *Camp Dodge, Iowa.*

MASON, GEO. R., lieutenant, A. E. F., *France.*

MATTHEWS, MEREDITH, sergeant of ordnance, 7th Mobile Ordnance Repair Shop, 7th Division, U. S. A., (mail) Camp McArthur, *Waco, Texas.*

MAY, HENRY, JR., first lieutenant, Quartermaster Corps, N. A., *Washington,* assigned as inspector of Type B engines.

MAYER, JAMES L., lieutenant, 109th Engineers, *Camp Cody, New Mexico.*

MEDER, CHARLES, Co. 51, U. S. Naval Air Station, *Pensacola, Fla.*

MERGI, WILLIAM, Co. B, First Battalion, 153d Depot Brigade, Camp Dix, *Wrightstown, N. J.*

METCALF, GEORGE R., JR., captain, Ordnance Department, U. S. N. A., *Washington.*

MICHEL, C. A., The Naval Auxiliary, Reserve Officers' Training School, Steamer J. H. Sheadle, River Station, *Detroit.*

MIDDLETON, RAY T., first lieutenant, Air Service, A. E. F., *Paris, France.*

MILLER, B. F., major, Quartermaster Corps, U. S. A., *Washington.*

MILLER, C. A., first lieutenant, Quartermaster Corps, N. A., Camp Holabird, *Colgate, Md.*

MILLER, DONALD G., first lieutenant, Ordnance R. C., U. S. A., (mail) Nash Motors Co., *Kenosha, Wis.*

MITCHELL, C. B., lieutenant, 4th Motor Mechanics' Regiment, *Camp Hancock, Ga.*

MOFFAT, ALEX. W., ensign, commanding U. S. S. "Tamarack" (S. P. 561), Naval Defense Reserve, Postmaster, Foreign Station, *New York.*

MOFFETT, PAUL R., captain, Aviation Section, Signal Corps, *Washington.*

MONCRIEFF, V. I., captain, Aviation Section, Signal R. C., *Washington.*

MOORE, HAROLD T., sergeant, Quartermaster Mobile Repair Shop No. 302, Co. 2, American Expeditionary Forces, via *New York.*

MORGAN, M. B., major, Engineering Bureau, Ordnance Department, *Washington.*

MORRISS, PERCY G. B., Naval Aviation Corps, U. S. Navy, *Washington,* (mail) Aviation Headquarters, Great Lakes Naval Station, *Great Lakes, Ill.*

MORSE, E. R., first lieutenant, Headquarters Sixth Mobile Ordnance Repair Shop, *Camp Wadsworth, S. C.*

MURPHY, JOSEPH G., Sanitary Corps, U. S. N. A., *Washington.*

MYERS, J. L., first lieutenant, Motor Equipment Section, Ordnance R. C., U. S. A., (mail) Allison Experimental Co., *Indianapolis.*

NAHIKIAN, S. M., lieutenant, Aviation School, Massachusetts Institute of Technology, *Cambridge, Mass.*

NICHOL, ALFRED H., corporal, Co. B, Motor Mechanics Training Detachment, University of Michigan, *Ann Arbor, Mich.*

NORRIS, G. L., captain, Signal R. C., U. S. A., *Pittsburgh, Pa.*

O'BRIEN, WM. B., JR., cadet, School of Military Aeronautics, Barracks No. 1, *Champaign, Ill.*

OGREN, CARL F., chief machinist's mate, Ordnance Inspection Department, U. S. N. R. F., *Washington.*

OLDFIELD, LEE W., captain, Signal R. C., *Washington,* assigned as aeronautical engineer.

OLIPHANT, LAURENCE, ensign, U. S. N., *Washington.*

OMMUNDSON, H. P., chief quartermaster, Aviation, U. S. Naval Air Station, *Miami, Fla.*

ONG, D. G., first lieutenant, Aviation Section, Signal Reserve Corps, U. S. A., *Dayton, Ohio.*

ORTON, EDWARD, JR., major, Quartermaster R. C., *Washington,* assigned to Motor Transport Branch, Engineering Section.

OSBORNE, ARTHUR D., second lieutenant, Ordnance R. C., U. S. A., *Washington.*

OSWALT, W. L., first lieutenant, Ordnance R. C., 304th Mobile Ordnance Repair Shop, *Camp Meade, Md.*

OTTO, HENRY S., lieutenant, Intelligence Section, A. E. F., *France.*

PAGÉ, VICTOR W., captain, Aviation Section, Signal Corps, A. E. F., *France.*

PAINE, C. L., captain, Ordnance R. C., U. S. A., Headquarters 7th Mobile Ordnance Repair Shop, Camp McArthur, *Waco, Texas.*

PARKER, RICHARD E., captain, Quartermaster R. C., *Washington,* assigned to Southern Department.

PARRAMORE, T. H., Motor Transport Service, Quartermaster Corps, U. S. A., *Washington.*

PARRETT, DENT, captain, Ordnance Department, U. S. A., *Peoria, Ill.*, assigned to work of coordination of engineering, production and inspection in tractor factories in Middle West.

PEARMAIN, W. J., captain, Ordnance R. C., A. E. F., *France.*

PECHNICK, FRANK J., 31st Balloon Co., U. S. A., Post Field, *Ft. Sill, Okla.*

PETERSON, F. SOMERS, ensign, Naval Air Station, *San Diego, Cal.*

PETTIS, JOHN G., chief machinist's mate, Aviation Section, U. S. N., *Washington.*

PFEIFFER, BEN. S., first lieutenant, Ordnance R. C., Rock Island Arsenal, *Rock Island, Ill.*, assigned to Motor Section.

PICKARD, LYNN W., chief machinist's mate, U. S. Naval Air Service, A. E. F., *France.*

PIERCE, HUGH M., captain, Signal Corps, Kelly Field, *San Antonio, Texas,* assigned as engineer officer, Aviation Section.

POST, EDWIN M., JR., lieutenant, U. S. Air Service, A. E. F., *France.*

POTTER, AUSTIN E., lieutenant, U. S. N. R. F., U. S. Naval Aviation Forces, *France.*

POWELL, W. B., captain, assigned as officer in charge of mechanical transport, Imperial Ministry of Munitions, *Quebec, Can.*, (mail) P. O. Box 194.

PRATT, JESSE T., first lieutenant, Aviation Section, Signal Corps, U. S. A., *Washington.*

PROCTOR, C. D., corporal, Ordnance Department, U. S. A., Ordnance Depot, *Chicago.*

PULLEN, DANIEL D., lieutenant colonel, General Headquarters, A. E. F., A. P. O. 706, *France.*

PURCELL, BERNARD A., captain, Quartermaster R. C., 307th Supply Train, *Camp Gordon, Ga.*, assigned as Commanding Officer.

RANNEY, A. ELLIOT, major, Air Division, Signal Corps, U. S. A., *Washington.*

RAWLEY, JOS., captain, Co. A, 310 Engineers, U. S. A., Camp Custer, *Battle Creek, Mich.*

RICHARDSON, F. E., private, Engineer R. C., U. S. A., *Washington.*

RIDDLE, E. C., cadet, Aviation Section, Gerstner Field, *Lake Charles, La.*

RIFKIN, G., sergeant, inspector, Military Truck Production Division, Quartermaster Corps, U. S. N. A., (mail) Covert Gear Works, *Lockport, N. Y.*

RITTER, E. R., first lieutenant, Ordnance R. C., U. S. A., *Washington,* assigned to Production Division, Carriage Section.

ROBINSON, H. A., ensign, N. R., U. S. N., *Keyport, N. J.*

ROSE, CHARLES B., major, chief of planes and engine inspection, Inspection Department, Signal Corps, U. S. A., *Washington.*

ROMEYN, RADCLIFFE, Inspection Division, Ordnance Department, *Washington.*

ROSENTHAL, WM. C., sergeant, Engineer O. T. C., *Camp Lee, Va.*

ROUNDS, EDWARD W., U. S. N. R., U. S. Naval Aviation Detachment, *Cambridge, Mass.*

RUMNEY, MASON P., captain, Production Division, Ordnance R. C., *Washington.*

RUSSELL, EUGENE F., major, Ordnance Department, U. S. A., *Washington.*

SANDT, A. R., sergeant, Ordnance Department, U. S. A., *Washington,* assigned to Motor Equipment Section, Engineering Bureau.

SCHOENFUSS, F. H., captain, Gun Division, Production Section, Ordnance R. C., *Washington.*

SCHOEPF, T. N., captain, Engineer R. C., *Washington.*

SCHUPP, ARTHUR A., second lieutenant, Aviation Section, Engineering Department, New York Equipment District, Signal Corps, U. S. A., *Washington.*

SCOTT, ALLISON F. H., captain, Signal Corps, U. S. A., Langley Field, *Hampton, Va.*, assigned to Aviation Section.

SEELEY, S. WARD, private 326th Field Signal Battalion, Headquarters Det., Camp Wadsworth, S. C., (mail) care of C. E. Seeley, 4040 Green St., *Philadelphia.*

SELFRIDGE, S. W., first lieutenant, Ordnance R. C., *Washington.*

SEWALL, E. B., U. S. N. R. F., *Washington.*

SHAFER, M. S., second lieutenant, Signal R. C., McCook Field, *Dayton, Ohio,* assigned to Airplane Eng. Div.

SHEAHAN, T. W., lieutenant, 12th Company, Third Training Battalion, Barracks 930, N. A., *Camp Lee, Va.*

SKINNER, HARLAN C., Officers' Motor Instruction School, Barracks C 11, Camp Raritan, *Metuchen, N. J.*

SLADE, ARTHUR J., captain, Aviation Section, unattached, A. E. F., *France.*

SLOANE, JOHN E., first lieutenant, aeronautical engineer, Aviation Section, Signal Corps, U. S. A., *Washington.*

SMITH, EDSON H., ensign, U. S. N. R., (mail) American & British Mfg. Co., *Bridgeport, Conn.*, assigned as assistant naval inspector of Ordnance.

SMITH, FRANK E., major, Signal Corps, U. S. A., *Washington.*

SMITH, G. W., JR., lieutenant, U. S. N. R., Naval Aircraft Factory, U. S. Navy Yard, *Philadelphia.*

SMITH, MARK A., first lieutenant, Marine Corps, U. S. N., *Washington.*

SMITH, WESTCOTT T., second lieutenant, Engineering Department, Aviation Section, Signal R. C., U. S. A., Chaunte Field, *Rantoul, Ill.*

SPENCE, HANS P., first lieutenant, Quartermaster Corps, U. S. A., *Camp Custer, Mich.*

SPERRY, LAWRENCE B., ensign, U. S. N. R. F., *Massapequa, N. Y.*

SPRAGUE, G. A., Co. D, 310th Engineers, Camp Custer, *Battle Creek, Mich.*

STAHL, R., lieutenant, U. S. Navy Seaplane Division, U. S. N. R., *Washington.*

STALB, A. R., ensign, U. S. N. R. F., Experimental Department, Naval Air Station, *Norfolk, Va.*

STEINAU, J. M., sergeant, Sanitary Corps, U. S. N. A., *Washington.*

STEVENS, C. C., Motor Equipment Section, Ordnance Department, U. S. A., *Washington,* assigned as draftsman.

STRAHLMAN, OTTO E., first lieutenant, Aviation Section, Signal R. C., (mail) Mechanics Training School, Overland Bldg., *St. Paul, Minn.*

STRAUSS, M. FRANK, first lieutenant, 307th Mobile Ordnance Repair Shop, 82nd Division, U. S. A., *Camp Gordon, Ga.*

STREETER, ROBT. L., major, Ordnance Department, U. S. A., *Rock Island Arsenal, Ill.*, in charge of truck and tractor experimental work.

STREICHER, GEORGE A., lieutenant, 3rd Engineers' Training Regiment, *Camp Humphrey, Va.*

STURGIS, G. B., chief machinist's mate, U. S. N. R. F., assistant inspector engineering material, Allis-Chalmers Co. Works, *West Allis, Wis.*

SWEET, GEO. P., first lieutenant, Signal Corps, U. S. A., *Washington,* assigned to Aviation Section.

SWEET, GEO. W., captain, Ordnance Department, U. S. A., *Washington,* assigned as inspector of ordnance, Studebaker Corp., *South Bend, Ind.*

SWINTON, D. R., first lieutenant, Quartermaster Corps, U. S. N. A., Mobile Repair Shop 302, A. P. O. 708, A. E. F., *via New York.*

TAYLOR, PAUL B., sergeant, Medical Corps, U. S. A., *Pontiac, Mich.*

TAYLOR, S. G., JR., first lieutenant, Ordnance R. C., *Washington.*

TEETOR, D. C., captain, Ordnance R. C., *Kenosha, Wis.*, assigned to Motor Section.

THOMPSON, H. E., first lieutenant, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

THOMPSON, JOHN A., Ordnance Department, U. S. A., assigned to Engineering Bureau, Motor Equipment Section, Ford Bldg., *Washington.*

THOMPSON, W. H. F., machinist's mate, U. S. Naval Aviation Forces, Dunkirk, (mail) Postmaster, *New York City.*

TITSCH, WALTER H., captain, Quartermaster Corps, U. S. N. A., A. E. F., *France.*

TOLMAN, EDGAR BRONSON, JR., first lieutenant, 311th Engineers, U. S. A., Camp Grant, *Rockford, Ill.*

TURNER, HARRY C., captain, Engineer R. C., A. E. F., *France.*

TWACHTMAN, QUENTIN, first lieutenant, Engine Design Section, Signal R. C., *Washington.*

TYLER, P. O., captain, Ordnance R. C., U. S. A., Raritan Arsenal, *Nixon, N. J.*

UNDERHILL, C. R., captain, radio officer, school for aerial observers, Aviation Section, Signal R. C., Langley Field, *Hampton, Va.*

VAIL, E. L., lieutenant, Aviation Section, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio,* assigned as officer in charge of instruments and accessories.

VAN LOON, HENRY M., 310th Engineers, Camp Custer, *Battle Creek, Mich.*

VERITY, CALVIN W., captain, superintendent of forge shop, Ordnance R. C., Frankfort Arsenal, *Philadelphia.*

VINCENT, JESSE G., lieutenant colonel, U. S. A., assigned as commanding officer and chief engineer, McCook Field, *Dayton, Ohio.*

VONACHEN, F. J., lieutenant, Ordnance Department, U. S. N. A., Rock Island Arsenal, *Rock Island, Ill.*

WADSWORTH, GEORGE R., major, chief engineer, Naval Aircraft Factory, Navy Yard, *Philadelphia.*

WALDON, SIDNEY D., colonel, Equipment Division, Signal Corps, U. S. A., *Washington.*

WALL, WILLIAM GUY, lieutenant colonel, Motor Equipment section, Engineering Division, N. A. *Washington.*

WALTER, MAURICE, first lieutenant, Ordnance R. C., *Washington.*

WALTON, FRANK, acting sergeant, Quartermaster Corps, U. S. A., Quartermaster Repair Unit, (mail) *Washington, D. C.*

WALTON, HAROLD E., 84th Aero Squadron, Signal Corps., U. S. A., Kelly Field, *San Antonio, Texas.*

WATSON, C. ROY, lieutenant, Aviation Section, Signal R. C., U. S. A., *Washington.*

WEEKS, PAUL, captain, Ordnance Department, U. S. A., *Washington.*

WEISS, ERWIN A., sergeant, Engineering Bureau, Motor Section, Ordnance Department, U. S. A., *France,* assigned as ordnance sergeant.

WELSH, W. E., Signal Corps, Aviation Section, U. S. A., *Washington.*

WETHERELL, S. P. JR., major, Quartermaster R. C., Motor Transport Service, A. E. F., *France.*

WHITTENBERGER, OWEN M., first lieutenant, Ordnance R. C., *Washington,* assigned to Office of Chief of Ordnance.

WILSON, H. C., major, 58th U. S. Artillery, Coast Artillery Corps, *Ft. Schuyler, N. Y.*

WILSON, T. S., lieutenant colonel, Field Artillery, *Santa Fe, N. M.*

WODEHOUSE, B. A., sergeant, Co. A, 339th Infantry, *Camp Custer, Mich.*

WOLFF, RUDOLPH D., U. S. N. R. F. No. 5, Great Lakes, U. S. A., assigned as chief petty officer.

WOOD, C. G., first lieutenant, Quartermaster Corps, U. S. A., *Washington,* assigned to Motor Transport Section, Office of Quartermaster general.

WOOD, FRANK B., captain, technical expert, Air Division, Signal R. C., U. S. A., *Washington,* (mail) 3rd Motor Mechanics Regiment, Camp Greene, *Charlotte, N. C.*

WOOD, HAROLD F., lieutenant, Specification Section, Equipment Division, Signal R. C., *Washington.*

WOODS, S. H., captain, Motor Transport Service, S. O. S., S. O. U., Headquarters A. E. F., *France.*

WORKMAN, LEE W., 670th Aero Squadron, Aviation Branch, *Morrison, Va.*

YONKIN, HARRY F., first lieutenant, Ordnance R. C., care Chief Ordnance Officer, A. P. O. No. 717, A. E. F., *France, via New York.*

CIVILIAN SERVICE

ADAMS, H. J., War Industries Board, *Washington.*

ADAMS, PORTER H., Office of the Section Commander, First Naval District, *Rockford, Me.*

ADAMS, RALPH L., Quartermaster Corps, U. S. A., *Washington,* assigned to Engineering Section, Motors Division.

AGINS, HERMAN J., draftsman, Quartermaster Corps, U. S. A., *Washington,* assigned to Motor Transport Division.

ANDERSON, E. S., mechanical engineer, Aviation Section, Signal Corps, U. S. A., Rockwell Field, N. Island, *San Diego, Cal.*

ANDERTON, H. C., aeronautical mechanical engineer, Production Engineering Department, Equipment Division, Signal Corps, U. S. A., Lindsey Building, *Dayton, Ohio.*

BARNABY, RALPH S., airplane inspector, Naval Reserve Flying Corps, *Buffalo, N. Y.*

BARNHARDT, GEO. E., aeronautical mechanical engineer, Signal Corps., U. S. A., Wilbur Wright Field, *Dayton, Ohio,* (mail) Cottage B6, Unit No. 1, Signal Corps, Aviation School, *Fairfield, Ohio.*

BARTON, CHAS. E., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio,* assigned to Airplane Eng. Department.

BELLING, G. C. C., assistant inspector of engineering material, U. S. NAVY, *Buffalo, N. Y.,* (mail) Curtiss Aeroplane & Motor Corp.

BLAKEMORE, THOMAS L., aeronautical engineer, Bureau of Construction & Repair, U. S. N., *Washington.*

BOURNE, STEPHEN N., secretary, Emergency Fleet Corporation, *Philadelphia.*

BOURQUIN, J. F., supervisor of chassis assembly, Military Truck Production Section, Office of Quartermaster General, *Washington.*

BRADFIELD, E. S., Engineering Department, Naval Factory, *Philadelphia.*

BREWER, ROBERT W. A., inspector of mechanical transports, British Army, London, Eng., (mail) Holt Mfg. Co., *Stockton, Cal.*

BROWN, WILLIAM G., Aircraft Division, Research Department, Bureau of Construction and Repair, Navy Department, *Washington.*

BUBNA, RICHARD C., designer, Engineering Office, Motor Transport Division, Quartermaster Corps, U. S. A., (mail) Room 305, Union Station, *Washington.*

BURTON, W. DEAN, aeronautical mechanical engineer, Signal Corps, U. S. A., *Fort Omaha, Neb.*

CALDWELL, FRANK W., aeronautical engineer, Aviation Section, Signal Corps, U. S. A., (mail) McCook Field, *Dayton, Ohio.*

CHAPMAN, ROBERT H., U. S. N., *Spartanburg, S. C.,* assigned to Aeronautical Division.

CHAUVEAU, ROGER, aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington.*

CHERRY, RALPH E., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio,* assigned to Airplane Engineering Department.

CLAASSEN, CHARLES W., inspector of Dayton district, Aircraft Production Department, Signal Corps, U. S. A., (mail) The Engel Aircraft Co., *Niles, Ohio.*

CLARK, ELMER J., Signal Corps, U. S. A., *Portland, Ore.,* assigned as district manager of inspection.

CLARKE, THOMAS A., Signal Corps, U. S. A., *Washington,* assigned to Aviation Section as production expert.

CLEAVER, B. J., Medical Corps, U. S. A., General Motors Truck Plant, *Pontiac, Mich.*

COSTELLO, JOHN V., aeronautical engineer, airplane engineering division, Signal Corps, *Dayton, Ohio.*

COWAN, STUART, special work, Clothing and Equipment Division, Manufacturing Branch, Office of Quartermaster General, 109 East Sixteenth Street, *New York.*

CORLETT, ROBERT C., student engineer of tests, U. S. Army Training School, Carnegie Institute of Technology, *Pittsburgh.*

CREAGER, F. L., in charge of electrical equipment tests, engineering laboratory, Motor Transportation Section, Quartermaster Corps, U. S. N. A., (mail) Room 205, Union Station, *Washington.*

CROW, HAROLD I., School of Military Aeronautics, University of California, *Berkeley, Cal.,* assigned as instructor in aeronautic engines.

DAVIS, CHARLES ETHAN, consulting engineer, Ordnance Department, *Washington.*

DEKLYN, JOHN H., technical assistant, National Advisory Committee on Aeronautics, *Washington.*

DENKINGER, GEORGE MARSHALL, Signal Corps, U. S. A., *Washington,* assigned to Aviation Section as aeronautical engineer.

DICK, ROBERT I., motor truck expert, Ordnance Department, *Camp Dodge, Iowa.*

DIFFIN, F. G., assistant to Chief of Production Department, Aircraft Board, *Washington.*

DRESSER, L. W., mechanical engineer, Motor Transportation Division, Engineering Section, Quartermaster Corps, U. S. A., (mail) Room 306, Union Station, *Washington.*

DUCORRON, C. A. F., Signal Corps, U. S. A., care Nordyke & Marmon Co., *Indianapolis,* assigned as senior inspector, Signal Service at Large.

DUVAL, EUGENE C., Signal Corps, U. S. A., assigned to Airplane Engineering Department, Mutual Home Bldg., *Dayton, Ohio.*

EDGERTON, A. H., gage supervisor, Detroit district, Bureau of Aircraft Production, 1550 Woodward Ave., *Detroit.*

EDMONDSON, D. E., U. S. Signal Service at Large, *Washington,* assigned as inspector of airplanes and airplane engines, Ericsson Mfg. Co., *Buffalo.*

EISELE, WILLIAM S., draftsman, Aviation Section, Signal Corps, U. S. A., *Washington.*

ELLIOTT, E. M., chief dispatcher, Emergency Fleet Corp., *Washington.*

ERICSON, FRIEHOF G., representative of Canada, International Aircraft Standards Board, *Washington.*

FERRY, PHILLIPS B., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

FLOGAUS, H. A., designer and checker, Motor Transport Engineering Division, U. S. A., (mail) Office of Quartermaster General, 205 Union Station, *Washington.*

FOWLER, HARLAN D., aeronautical mechanical engineer, Production Engineering Department, Signal Corps, *Washington.*

FRENCH, H. J., senior inspector, Pittsburgh District, Aviation Section, Signal Corps, U. S. A., *Philadelphia,* assigned to Inspection Department.

FROESCH, CHARLES, aeronautical mechanical engineer, Signal Service at Large, U. S. A., (mail) C. B. King, Duesenberg Motors Corp., *Elizabeth, N. J.*

FRYER, ROY C., chief instructor, starting, lighting and ignition division, War Educational Department, University of Cincinnati, *Cincinnati.*

GORMAN, E. J. B., U. S. Flying Corps, N. R., U. S. N., *Dayton, Ohio,* assigned to inspection of airplane engines, Dayton-Wright Aeroplane Co.

GRIFFITH, LEIGH M., technical expert, National Advisory Committee for Aeronautics, 4th St. and Missouri Ave., *Washington.*

GRIMES, C. P., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio,* assigned to airplane engineering department.

HALLETT, GEO. E. A., aeronautical mechanical engineer, Aviation Section, Signal Corps, Arcade Bldg., *Washington.*

HARRIGAN, F. P., aeronautical engineer, Equipment Division, Airplane Engineering Department, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

HART, FRANK S., designer, Engineering Section, Motor Transportation Division, Quartermaster Corps, U. S. A., *Washington.*

HECKEL, C. E., truck designer, Transport Division, Quartermaster Corps, U. S. A., *Washington.*

HICKS, H. A., aeronautical engineer, Equipment Section, Aviation Section, Signal Corps, U. S. A. (mail) Major E. J. Hall, Lindsey Building, *Dayton, Ohio.*

HILL, F. LEROY, JR., aeronautical mechanical engineer, Production Engineering Dept., Signal Corps, U. S. A., 612 Lindsey Bldg., *Dayton.*

HOBBS, J. W., automobile expert, Ordnance Department, Rock Island Arsenal, *Rock Island, Ill.*

HOLDEN, F. M., airplane engineering division, Signal Corps, U. S. A., *Washington.*

HONIGMAN, JOS. K., instructor, U. S. School of Military Aeronautics, Princeton University, *Princeton, N. J.*

HOWER, HENRY M., production manager, New London Naval Base, *New London, Conn.*

KING, CHARLES B., aeronautical mechanical engineer, Aviation Section, Signal Corps, (mail) Duesenberg Motors Corp., *Elizabeth, N. J.*

KINGSBURY, J. A., metallurgist, Aviation Section, Signal Corps, U. S. A., (mail) Trego Motors Corp., *New Haven, Conn.*

KUEMPEL, REUBEN, U. S. N., Naval Air Station, *Pensacola, Fla.*, assigned to Bureau of Steam Engineering.

LADDON, I. M., aeronautical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

LANE, ABBOTT A., inspector, Aviation Section, Signal Corps, (mail) Room 52, 870 Woodward Avenue, *Detroit.*

LEAVELL, R. A., War Dept., Committee on Education and Special Training, *Washington.*

LINCOLN, C. W., aeronautical mechanical engineer, Bureau Aircraft Production, U. S. A., *Washington.*

LONGLETZ, WESLEY, Signal Corps, U. S. A., assigned as inspector on airplane engines at The Nordyke & Marmon Co., *Indianapolis.*

LOOMIS, ALLEN, Bureau of Aircraft Production, McCook Field, *Dayton*, assigned to airplane engineering department.

LOUDON, WARREN P., expert cost accountant, Signal Corps, U. S. A., *New York.*

MACPHERSON, JAMES W., inspector of airplanes and airplane engines, Signal Service at Large, Signal Service, U. S. A., *Washington.*

MCCAIN, GEO. L., Signal Corps, U. S. A., *Dayton, Ohio*, assigned to airplane engineering department, Engine Design Section.

MCDONALD, E. G., aeronautical engineer, Airplane Engine Division, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

MCMASTER, MARCENUS D., Aviation Section, U. S. N. R. F., *Washington*, assigned as warrant officer and machinist.

MANN, ARTHUR S., sanitary division, Medical Corps, N. A., *Kankakee, Ill.*

MENNEN, F. E., Quartermaster Corps, U. S. A., *Washington*, assigned to Transportation Division.

MILLAR, THOMAS H., JR., Engineering Section, Motors Division, Quartermaster Corps, *Washington*, (mail) Office of Quartermaster General.

MILLER, C. S., automotive engineer, U. S. A., Washington; (mail) 1750 Elkin Ave., *New Albany, Ind.*

MOORHOUSE, A., Signal Corps, U. S. A., Lindsey Bldg., *Dayton, Ohio*, assigned as engineer in Airplane Eng. Dept.

MORGAN, G. W., supervisor of plant survey, Military Truck Production Section, Office of Quartermaster General, *Washington.*

MUNSON, CHARLES C., production expert, Approvals Dept., Bureau of Aircraft Production, U. S. A., *Washington.*

NELSON, A. L., aeronautical engineer, Airplane Engineering Department, Aviation Section, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

NEUMANN, JOHN W., Planning Section, Machine Division, U. S. Navy Yard, *Philadelphia.*

O'MALLEY, JOHN M., aeronautical engineer, Aviation Section, Signal Corps, U. S. A., Rockwell Field, *San Diego, Cal.*

OTIS, J. HAWLEY, Ordnance Department, U. S. A., Camp Dodge, *Des Moines, Iowa.*

PARISH, W. F., Supply Section, Bureau Military Aeronautics, *Washington*, assigned as chief of Oil and Lubrication Branch.

PARRIS, JR., EDWARD L., senior inspector, Aviation Section, Signal Corps, (mail) Ericsson Mfg. Co., *Buffalo.*

PERRIN, J. G., aeronautical mechanical engineer, Production Engineering Department, Signal Service at Large, care Major B. D. Gray, *Washington.*

POLLOCK, RAY C., Signal Corps, U. S. A., *Buffalo*, assigned as airplane engine inspector.

PROCTOR, C. D., Ordnance Department, U. S. A., Rock Island Arsenal, *Rock Island, Ill.*, assigned to Motor Section, Carriage Division.

RANDALL, J. M., assistant inspector of ordnance, Ordnance Department, U. S. A., (mail) Nash Motors Co., *Kenosha, Wis.*

REID, JAMES, supt. Forge Dept., Boston Navy Yard, *Boston.*

RICE, HARVEY M., inspector, Signal Service at Large, Signal Corps, (mail) Willys-Overland Co., *Toledo, Ohio.*

RIDER, W. KEITH, Production Engineering Department, Signal Corps, U. S. A., *Dayton.*

ROBERTS, D. S., Signal Corps, U. S. A., care Sturtevant Aeroplane Co., *Boston*, assigned as inspector of airplanes.

ROBERTS, SAMUEL B., Signal Corps, U. S. A., care Sturtevant Aeroplane Co., *Boston*, assigned as inspector of airplanes.

RUCKSTELL, G. E., Signal Corps, U. S. A., assigned as aeronautical mechanical engineer, *Detroit.*

RUSSEL, A. W., Office of Assistant Secretary of War, War Dept., *Washington.*

RUSSELL, L. L., Engineering Office, Motors Division, U. S. A., (mail) Office of Quartermaster General, 305 Union Station, *Washington.*

RYMARCZICK, GUSTAV M., Signal Corps, U. S. A., (mail) Splitdorf Electrical Co., *Newark, N. J.*, assigned to Aviation Sect., as senior inspector, Signal Service at Large.

SALISBURY, EDWARD V., chief of motor transportation, American International Corp., Government Shipbuilding Yard, Hog Island, *Philadelphia.*

SCHELL, JOHN A., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

SEABURY, W. M., Field Hospital, No. 337, Camp Custer, *Battle Creek, Mich.*

SEABURY, W. WARNER, Signal Corps, U. S. A., Bureau of Standards, *Washington*, assigned to testing of aviation instruments.

SEARLE, C. A., inspector of automobile parts, U. S. A., *Washington.*

SELLERS, MATTHEW B., Naval Consulting Board, *New York.*

SERRELL, ERNEST, aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington.*

SHAW, B. RUSSELL, Aviation Engineering Department, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

SHILLINGER, G. P., Ground Officers' Engineering School, Kelly Field No. 1, *San Antonio, Tex.*, assigned as instructor in ignition, starting and lighting.

SIMPSON, HOWARD W., Signal Corps, U. S. A., *Detroit*, assigned as inspector of aircraft engines, Inspection Section, Equipment Division, (mail) 870 Woodward Ave.

SMITH, JOSEPH E., mechanical draftsman, Engineering Division, Ordnance Bureau, *Washington.*

SOULIS, WILBUR T., mechanical engineer, United States Gas Defense Plant, *Long Island City, N. Y.*

SPENCER, LESLIE V., editor, technical publications, Airplane Engineering Dept., McCook Field, *Dayton, Ohio.*

SPRAGLE, R. L., inspector, Detroit district, Signal Corps, U. S. A., Garfield Building, *Detroit.*

STANTON, D. T., military instructor, U. S. Army School of Military Aeronautics, Cornell University, *Ithaca, N. Y.*

STEARNS, L. C., technical assistant, National Advisory Committee for Aeronautics, *Washington.*

STOUT, WILLIAM B., technical adviser, Aircraft Board, *Washington,*

STUART, H. R., Signal Corps, U. S. A., Lindsey Building, *Dayton, Ohio*, assigned as aeronautical mechanical engineer, Production Engineering Department.

SUTTILL, ALBERT G., Merchant Shipbuilding Corp., *Bristol, Pa.*, assigned as inspector of machinery, Boston District; (mail) General Delivery, *Hyde Park, Mass.*

THIBAULT, F. J., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

THOMAS, T. R., mechanical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

TONE, FRED I., inspector, Aviation Section, Signal Corps, *Washington.*

TRACY, PERCY WHEELER, supervisor of parts plants, Military Truck Production Section, Office of Quartermaster General, *Washington.*

UTZ, JOHN G., supervisor of inspection, Office of Military Truck Production Section, Office of Quartermaster General, *Washington.*

VOHRER, W. R., draftsman, Engineering Section, Motor Division, Quartermaster Corps, U. S. A., *Washington.*

WADE, GUSTAV, engineer, Bureau of Aircraft Production, (mail) Lieut. Col. E. J. Hall, Lindsey Bldg., *Dayton.*

WALDON, C. O., National Bureau of Standards, *Washington*, assigned as laboratory assistant, Military Research Gas Engines.

WALDRON, RUSSELL E., Signal Corps, U. S. A., *Detroit*, assigned to Equipment Division.

WALTER, JOHN M., mechanical draftsman, Bureau of Ordnance, Navy Department, *Washington.*

WARNER, EDWARD P., aeronautical engineer, Signal Service at Large, U. S. A., Mass. Institute of Technology, *Cambridge, Mass.*

WATERHOUSE, W. J., aeronautical engineer, Aviation Section, Signal Corps, (mail) Dayton-Wright Airplane Co., *Dayton, Ohio.*

WEAVER, E. W., aeronautical engineer, Engineering Department, Naval Aircraft Factory, Navy Yard, *Philadelphia.*

WHINNE, WILBUR H., inspector, Quartermaster Corps, U. S. A., *Detroit.*

WILLIAMS, S. T., Naval Aircraft Factory, Navy Yard, *Philadelphia, Pa.*, assigned as aeronautical mechanical engineer in Engineering Department.

WINTER, E. A., War Department, Rock Island Arsenal, *Rock Island, Ill.*

WOODWORTH, P. B., district educational director, War Department, Tribune Building, *Chicago*, (mail) 5809 Race Ave., *Chicago.*

WORTHEN, C. B., inspector, Aviation Section, Signal Corps, U. S. A., *Washington.*

WRIGHT, E. H., Bureau of Aircraft Production, McCook Field, *Dayton*, assigned to factory manager's office, experimental department.

YOUNGER, JOHN, Quartermaster Corps, U. S. A., *Washington*, assigned to Motor Transport Service, as chief engineer.

Applications *for* Membership

The applications for membership received between July 25 and Aug. 15, 1918, are given below. The members of the society are urged to send any pertinent information with regard to these names which the Council should have for consideration prior to their election. It is requested that such communications from members should be sent promptly.

BECK, CHARLES W., president, general manager, Michigan Motor Specialties Co., *Detroit.*

BELL, LAWRENCE D., factory manager, the Glenn L. Martin Co., *Cleveland, Ohio.*

BROWN, PHELPS, president, Witherbee Igniter Co., *Springfield, Mass.*

BUELOW, HENRY A., draftsman, Oneida Motor Truck Co., *Green Bay, Wis.*

BURNSHAW, E. W., JR., secretary, treasurer, general manager, Girard Automobile Co., *Philadelphia.*

CARRITTE, J. P., general manager, treasurer, McAdamite Aluminum Co., *Detroit.*

COLBOURNE, JAMES, manager, General Electric Co., *New York City.*

DAY, W. E., JR., erecting superintendent, International Motor Co., *Plainfield, N. J.*

DE LA MONTE, C. H., experimental engineer, International Motor Co., *New York City.*

DITTMANN, M. C., vice-president, general manager, American Bronze Corp., *Berwyn, Pa.*

DONALDSON, JOHN E., inspector, Nordyke & Marmon Co., *Indianapolis, Ind.*

DREYFUS, ALEX. F., manager, City Sales Agency, *New Orleans.*

EDWARDS, JOSEPH B., president, general manager, Kellogg Switchboard & Supply Co., *Chicago.*

EGGENWEILER, CHARLES W., superintendent, General Aluminum & Brass Mfg. Co., *Detroit.*

FISHER, W. A., president Fisher Body Corp., *Detroit.*

FLETCHER, ANDREW, JR., asst. to pres. and vice-pres., W. & A. Fletcher Co., *Hoboken, N. J.*

GRAHAM, R. C., chief draftsman, Ross Gear & Tool Co., *LaFayette, Ind.*

GRUBB, JOSEPH K., chief draftsman, Truck Unit, Office Engineering Bureau, U. S. Army, *Indianapolis.*

GRUSS, A., general superintendent, Doehler Die Casting Co., *Brooklyn.*

HECHT, E. A., chief mechanical draftsman, Mansfield Rubber Co., *Mansfield, Ohio.*

HOWLETT, JOHN A., second lieutenant, government inspector, Q. M. C., N. A., care of Muncie Gear Works, *Muncie, Ind.*

HRONEK, FRANK J., 1st Class Sergeant, Engineering Bureau, Ordnance Department, care of Grant Motor Car Corp., *Cleveland, Ohio.*

HUSTED, DONALD R., aeronautical engineer, Curtiss Eng. Corp., *Garden City, N. Y.*

JOHNSON, CHARLES, Detroit representative, Square Turn Tractor Co., *Detroit.*

KAY, JARVIS, general foreman, Metal Forming Corp., *Elkhart, Ind.*

LAKIN, JOHN ROBERT, head Educational Dept., the Domestic Engineering Co., *Dayton.*

LANNON, JOHN, superintendent, Remington Arms Co., *Bridgeport, Conn.*

LAUER, CARLETON J., experimental engineer, Doble-Detroit Steam Motors Co., *Detroit.*

LAWRENCE, HERBERT S., chief inspector, Milburn Wagon Co., *Toledo, Ohio.*

LAYMAN, W. A., president, Wagner Electric Mfg. Co., 6400 Plymouth Ave., *St. Louis.*

LEWIS, I. M., vice-president, treasurer, manager, Bessemer Motor Truck Co., *Grove City, Pa.*

LEWIS, WILL IRBY, inspector, Bureau of Aircraft Production, Nordyke & Marmon Co., *Indianapolis.*

MARSH, R. C., ignition expert, Best Hannan Electric Co., *Chillicothe, Ohio.*

MATHEWSON, E. T., district engineer, S. K. F. Ball Bearing Co., *Buffalo, N. Y.*

MCCALLUM, JAMES R., chief engineer, Militor Corp., *Jersey City, N. J.*

MOFFETT, CHARLES W., general manager, Warren Machine Products Co, *Warren, Pa.*

MORSE, JOHN C., aeronautical mechanical engineer, Bureau of Aircraft Production, McCook Field, *Dayton.*

MURRAY, EARL LEROY, factory representative, technical man, Myles Standish Mfg. Co., *Omaha, Neb.*

NEARING, DUDLEY W., engineer, the New Departure Mfg. Co., *Bristol, Conn.*

NEDOMA, CHARLES L., secretary to vice-president, Cadillac Motor Car Co., *Detroit.*

NEWSON, D. J., chief draftsman, Canadian Aeroplanes, Limited, *Toronto, Ont.*

NICHOLS, JOHN T., chief engineer, North American Motors Co., chief engineer and purchasing agent, Chadwick Engineering Works, *Pottstown, Pa.*

NOLTING, FREDERICK G. A., purchasing agent, Premier Motor Corp., *Indianapolis.*

NORTHRUP, L. M., sales engineer, Joseph T. Ryerson & Son, *Chicago, Ill.*

ODEN, ERMUN D., draftsman, Rutenber Motor Co., *Marion, Ind.*

PATTON, F. H., assistant engineer, Westinghouse Electric & Manufacturing Co., *East Pittsburgh.*

POPP, HAROLD M., director of purchases, Curtiss Aeroplane & Motor Corp., *Hammondsport, N. Y.*

POYNOR, FREDERICK W., chief engineer, R. Martens & Co., Ltd., 149 Leadenhall St., E. C. 3, *London, England.*

QUINN, JOHN LEWIS, district sales manager, Standard Oil Co., *Los Angeles, Cal.*

REID, JOSIAH E., assistant engineer, International Motor Co., *New York City.*

RUSK, EDWARD I., engineer, General Electric Co., *New York City.*

SCHUEHLE, WALTER A., aeronautical mechanical engineer, Signal Corps, McCook Field, *Dayton.*

SEIBERLING, FRANK A., president, the Goodyear Tire & Rubber Co., *Akron, Ohio.*

SIEBENTHALER, NORMAN D., sales engineer, Dayton Engineering Laboratories Co., *Dayton.*

SIMS, E. M., secretary, treasurer, Metal Forming Corp., *Elkhart, Ind.*

SMITH, CARLISLE F., layout draftsman, Haynes Automobile Co., *Kokomo, Ind.*

SNYDER, C., general superintendent, Hinkley Motors Corp., *Detroit.*

STANLEY, R. W., general manager, New York Branch, General Electric Co., *New York City.*

SUMMERLEE, S. S., chief draftsman, Maxwell Motor Co., *New Castle, Ind.*

TREGENZA, W. E., master mechanic, efficiency engineer, Canadian Aeroplanes, Ltd., *Toronto, Can.*

VAN DE VELDE, PAUL GEORGE, captain, French High Commission, *Washington.*

VER LINDEN, EDW., president, Olds Motor Works, *Lansing, Mich*

VOLLMER, WALTER G., assistant engineer, One Wheel Truck Co., *St. Louis.*

VOUGHT, R. R., asst. manager, Lewis & Vought Corp., *Long Island City, N. Y.*

WAGNER, P. C., sales engineer, Blood Brothers Machine Co., *Allegan, Mich.*

WARNER, CHARLES F., designer, Sheffield Car Co., *Three Rivers, Mich.*

WELLER, GLENN, layout draftsman, Grant Motor Car Co., *Cleveland.*

WHIPP, W. E., secretary, treasurer and general manager, the Monarch Machine Tool Co., *Sidney, Ohio.*

WHITACRE, CLARENCE J., assistant engineer, Chevrolet Motor Co., *New York City.*

ZEICHNER, FRANK H., chief draftsman, Poole Engr. & Mach. Co., *Woodberry, Md.*

Applicants *Qualified*

The following applicants have qualified for admission to the Society between July 17 and Aug. 14, 1918. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate; (Aff. Rep.) Affiliate Representative; (S. E.) Student Enrollment.

ANDERSON, CARL L. (A) superintendent, Mechanics Machine Co. *Rockford, Ill.*

ANDERSON, E. G. (A) sales manager, American Bronze Corp., *Berwyn, Pa.*

ARTHUR, FRANK A. (Aff. Rep.) gen. supt., The Federal Rubber Co., *Cudahy, Wis.*

BARKER, GEORGE R. (A) auditor, Perfex Radiator Co., *Racine, Wis.*

BARTON, GEORGE K. (A) manager of Detroit Branch, the Texas Co., 1059 W. Grand Blvd., *Detroit.*

BECKMAN, WILLIAM R. (M) exper. engr. and designer, Duesenberg Motors Corp., *Elizabeth, N. J.,* (mail) 1108 North Ave.

BLOMGREN, OSCAR (J) draftsman, International Motor Co., N. Y. C., (mail) 1491 Westchester Ave., *The Bronx, New York City.*

BOYER, WALLACE E. (A) assistant foreman, Thomas E. Adams, Inc., (mail) 2 Grove St., *New York City.*

BRADLEY, ROBERT G. (M) Western rep., Spring Div., The Standard Parts Co., *Cleveland, Ohio.*

BREWSTER, C. P. (A) Detroit manager, Edward A. Cassidy Co., Inc., New York, (mail) Hotel Plaza, *Detroit.*

BRIDGE, ROBERT BERRY (A) engineer officer, 217th Squadron Air Service, U. S. R., *Mitchel Field, Long Island, N. Y.*

BURCH, ALBERT C. (A) president, Signal Motor Truck Co., *Detroit,* (mail) 515 Jefferson Ave. E.

BURNETT, ROBERT S. (M) assistant to Standards Manager, Society of Automotive Engineers, *New York City.*

CAMPBELL, ROBERT H. (A) purchasing agent, Comet Automobile Co., *Decatur, Ill.*

CAMPBELL, SUMNER E. (M) chief chemist, Tide Water Oil Co., Bayonne, N. J., (mail) 821 Cross Ave., *Elizabeth, N. J.*

CAMUSAT, MAURICE (M) tool engineer, Automobiles Delage a Courbevoie, France, (mail) 31 Rue de Chezy, *Neuilly-s-Seine.*

CARINGTON, ROBERT W. (A) representative lubricating engineering department, Standard Oil Co., *Chicago,* (mail) 11947 Harvard Ave.

CARTER, EDGAR R., JR. (M) mechanical engineer, the Fafnir Bearing Co., *New Britain, Conn.*

CERVENKA, JOHN A., Capt. (A) commander of casuals, Q.M.C., N.A., Camp Meigs, *Washington,* (mail) 639 E. Capitol St.

CHENOWETH, OPIE (SE) student, Purdue University, (mail) Box 45, W. *Lafayette, Ind.*

CLAASSEN, CHARLES W. (A) inspector, Signal Corps U. S. A., The Engler Aircraft Corp., *Niles, Ohio,* (mail) 2627 Highland Ave., *Cincinnati.*

CONGER, ROU U. (A) vice-president, Erie Specialty Co., 8 W. 40th St., *New York City,* (mail) 52 Vanderbilt Ave.

CRITTENDEN, C. LAVEARN (A) chief draftsman of motorcycle department, the Militor Corp., Jersey City, N. J., (mail) Room 4J, 138 East 38th St., *New York City.*

CROWHURST, H. W. (J) lieutenant exper. laboratory research asst., Eng. Sec., Motors Div., Q.M.C., N.A., Washington, (mail) Camp Holabird, *Colgate Creek, Md.*

DAVIS, RALPH W. (M) chief engineer, Mitchell Motors Co., Inc., *Racine, Wis.,* (mail) 1517 Wisconsin St.

DODGE, H. B. (M) asst. chief engr., Four Wheel Drive Auto Co., *Clintonville, Wis.*

DONNELLY, JAMES (M) in charge of engineering department, Continental Motors Corp., *Muskegon, Mich.*

ELLIS, RUSSELL S. (A) vice-pres. and gen. mgr., Motor Efficiency Corp., *Philadelphia, Pa.,* (mail) 1502 N. 15th St.

ERD, H. S. (M) managing director, Chief Motor Co., Ltd., *Port Huron, Mich.*

FABER, CHARLES J. (J) designer, Airplane Eng. Department, Bureau of Aircraft Production, Fergus Motors of America, Inc., (mail) 150 Sherman Ave., *Jersey City, N. J.*

FEDERAL RUBBER CO., THE (Aff. Mem.) *Cudahy, Wis.* Representatives: Arthur A. Frank, gen. factory supt.; Leon J. D. Healy, chief chemist; John Scherner, mechanical engineer.

FINE, LEWIS (M) chief engineer, Budd Wheel Corp., *Philadelphia,* (mail) 1913 Christian St.

FLINT, BRILSFORD P. (M) prod. engr., Yuba Mfg. Co., Marysville, (mail) 518 E. St., *Marysville, Cal.*

FULLER, C. T. (J) inspector of engineering drawings, Naval Aircraft Factory, U. S. Navy Yard, *Philadelphia.*

GARFIELD, ELLERY IRVING (J) mechanical engineer, Renault Automobile Factories, *Billancourt (Seine), France.*

GEORGE, EDWIN S., colonel (A) Procurement Div., Motor Transport Service, N. A., Group F, Wing 7, *Washington.*

HALSEY, W. D. (M) mech. engr., National Advisory Committee for Aeronautics, Washington; asst. prof. of mech. engr., George Washington University, Washington, (mail) Apt. 44, 1801 Wyoming Ave., *Washington.*

HARDING, HERBERT P. (A) engineering and sales, Harding & Co., 122 S. Michigan Ave., *Chicago.*

HEALY, LEON J. D. (Aff. Rep.) chief chemist, Federal Rubber Co., *Cudahy, Wis.*

HILL, F. LEROY, JR. (J) aeronautical mechanical engineer, Production Engineering Department, Signal Corps, U. S. A., Lindsey Bldg., *Dayton.*

HILL, NESTOR F. (A) assistant service manager, Gramm-Bernstein Sales Corp., *New York City,* (mail) 922 Morris Ave.

HOUSE, HARRY A., JR. (M) chief engineer, Wire Wheel Corp. of America, (mail) 42 Fordham Drive, *Buffalo, N. Y.*

HUDSON, W. R. (M) associate manager, the Troy Wagon Works Co., *Troy, Ohio.*

HUGHES, EDWARD (M) sales engineer, Dayton Engineering Laboratories Co., *Dayton,* (mail) 925 N. Broadway.

HURD, ROLLIN V. (A) sales manager, Victor Screw Works, 240 John R St., *Detroit.*

JACOBS, A. F. (A) engineering department, Splitdorf Electrical Co., 98 Warren St., *Newark, N. J.*

JOHNSON, FREDERICK H. (A) inspector of airplanes, Bureau of Construction and Repair, Gallaudet Aircraft Corp., *E. Greenwich, R. I.,* (mail) E. L. Stewart, Cedar St.

JOHNSON, IRA L. (M) mechanical engineer, Minneapolis Steel & Machinery Co., *Minneapolis,* (mail) 3432 Longfellow Ave. S.

JOHNSTON, W. S. (A) engineering department, Naval Aircraft Factory, Navy Yard, *Philadelphia,* (mail) The Majestic, Broad and Girard Sts.

KALMES, JOSEPH W. (A) purchasing agent, Four Wheel Drive Auto Co., *Clintonville, Wis.,* (mail) 33 North Main St.

KARLL, W. R. (M) chief engineer, Perfex Radiator Co., *Racine, Wis.,* (mail) 1447 College Ave.

KNOCKE, LOUIS T. (M) in charge of testing laboratory, Waukesha Motor Co., *Waukesha, Wis.*

LANDAUER, ARTHUR (J) motor testing, Joseph Tracy, 1790 Broadway, *New York City,* (mail) *Ramsey, N. J.*

LANG, G. J. (M) chief engineer, Bosch Magneto Co., 223 W. 46th St., *New York City.*

LAWTON, OTTO A. (A) owner and manager, Franklin Motor Car Co., 616 Commonwealth Ave., *Boston.*

LECAIN, J. H. (M) aviation motor instructor, Mass. Inst. of Tech., *Boston,* (mail) 62 Richdale Ave., *N. Cambridge, Mass.*

LOWE, FRANK J. (A) superintendent, Bronx County Auto Co., Inc., *New York City,* (mail) 603 Academy St.

LUDLOW, ISRAEL (M) president, Aeronautical Equipment Co., Inc., 1 Wall St., *New York City.*

MADISON, R. D. (A) chief draftsman, Motor Equipment Section, Ordnance Engineering Bureau, 448 N. Capitol Ave., *Indianapolis.*

MARCUS, CHARLES (M) chief engineer, Bijur Motor Appliance Co., *Hoboken, N. J.*

MARTINEAU, FRANCIS L. (M) consulting engineer, 15 Avonmore Road, London, W. 14, England, (mail) Hotel Belmont, East 42nd St., *New York City.*

MEREDITH, G. W. (M) senior inspector, Bureau of Aircraft Production, Plant 17, Fisher Body Corp., *Detroit,* (mail) 729 Roosevelt Ave.

MICKELSON, OTTO (M) chief engineer, Avery Co., *W. Allis, Wis.*

MURRAY, J. R. (A) secretary, treasurer and production manager, J. W. Murray Mfg. Co., *Detroit* (mail) 18 Mt. Vernon Ave.

MURRAY, JOHN W. (A) president, J. W. Murray Mfg. Co., *Detroit.*

MUSSELMAN, C. A. (A) treasurer and general manager, the Chilton Co., *Philadelphia.*

NEWTON, LEONARD V. (A) supervisor of equipment, the Texas Co., 322 S. Michigan Ave., *Chicago.*

NORTON, F. H. (J) aeronautical engineer, Bureau of Aircraft Production, Mass. Inst. of Tech., (mail) 55 Chestnut St., *Boston.*

OBER, SHATSWELL (J) aeronautical engineer, Airplane Engineering Department, Bureau of Aircraft Production, Mass. Inst. of Tech., Boston, (mail) 22 Oakland Ave., *Arlington Heights, Mass.*

O'DONNELL, L. A. (A) treasurer and vice-president, the Gary Motor Truck Co., 2320-40 W. 9th St., *Gary, Ind.*

ORTLA, FREDERICK L. (A) superintendent of motor vehicles and mechanical superintendent Metropolitan Coal Co., Boston, (mail) 23 Pinckney Road, *Dorchester.*

PETERSON, J. W. (M) factory manager and in charge of engineering department, King Motor Car Co., *Detroit* (mail) 346 Garland Ave.

PETTIT, GEORGE H. (J) chief engineer, Atterbury Motor Car Co., *Buffalo, N. Y.* (mail) 187 Merrimac St.

PLATE, ROBERT T. (J) detail draftsman, Grant Motor Car Corp., *Cleveland* (mail) 4145 E. 104th St.

POMEROY, G. M. (J) aeronautical mechanical engineer, Naval Aircraft Factory, Navy Yard, *Philadelphia,* (mail) the Lenox Apts., 13th and Spruce Sts.

PUFF, MICHAEL J. (A) designer, Airplane Engineering Department, Bureau of Aircraft Production, Fergus Motors Co., 370 Jelliff Ave., *Newark, N. J.*

QUINN, W. J. (A) laboratory assistant, Engineering Branch, Motor Transportation Section, Quartermaster Corps, *Washington,* (mail) 1122 Fairmont St., N.W.

RADACK, HARRY E. (J) second lieutenant, Motor Transport Division, Quartermaster Corps, N. A., *Washington.*

RANKIN, CYRUS J. (A) technical work in service department and purchasing, Willys-Overland, Inc., 521 W. 57th St., *New York City,* (mail) 15 Seaman Ave.

RISCH, CHARLES H. (J) sales engineer's assistant, Fansteel Products Co., Inc., 2 Columbus Circle, *New York City.*

RYDER, SAMUEL E. (A) sales promotion, the Moto-Meter Co., Inc., 15 Wilbur Ave., *Long Island City, N. Y.*

RYDSTEDT, S. D. (A) designer, Stewart-Warner Speedometer Corp., 826 Diversey Parkway, *Chicago,* (mail) 3004 Blaine Place.

SCHERNER, JOHN (Aff. Rep.) mechanical engineer, the Federal Rubber Co., *Cudahy, Wis.*

SCHLENDORF, J. M. (A) director of sales, the Central Steel Co., *Massillon, Ohio.*

SCHMIDT, FREDERICK J. (J) draftsman, International Motor Co., *New York City,* (mail) 207 East 16th St.

SEARS, F. B. (A) treasurer, Auburn Automobile Co., *Auburn, Ind.*

SHARP, H. OAKLEY (A) engineer and manager, pump department, West Side Foundry Co., *Troy, N. Y.,* (mail) 63 Collins Ave.

SMITH, HAROLD C. (M) president, Illinois Tool Works, 154 E. Erie St., *Chicago.*

SMITH, JOSEPH E. (J) mechanical draftsman, Engineering Division, Ordnance Bureau, Washington, (mail) Route 1, Box 169, *Brazil, Ind.*

SPRINGER, JOHN (M) chief engineer, Dickinson Cord Tire Corp., 250 W. 54th St., *New York City.*

STEELE, E. JAMES (A) traveling salesman, automobile equipment department, Waltham Watch Co., *Waltham, Mass.*

STONE, E. WADSWORTH (A) mechanical engineer, Meyer Morrison & Co., 149 Broadway, New York City, (mail) 725 Kenmore Place, *Brooklyn, N. Y.*

STORER, FRANK A. (A) secretary, treasurer and general manager, Wire Wheel Corp. of America, 1700 Elmwood Ave., *Buffalo.*

SWAIN, J. G. (M) vice-president, the Firestone Steel Products Co., *Akron, Ohio,* (mail) 150 Edgerton Road.

TILLSON, BENJ. F. (M) head of mining department, New Jersey Zinc Co., *Franklin, Sussex County, N. J.*

TOMLINSON, EDWARD J. (J) experimental engineer, Splitdorf Electrical Co., *Newark, N. J.,* (mail) 344 High St.

VAN DER LINDE, VICTOR G. (M) development manager, the B. F. Goodrich Co., *Akron, Ohio.*

VAN PELT, H. B. (A) vice-president and manager of sales, Pittsburgh Shafting Co., *Detroit.*

VAN SICKLEN, N. H. (A) president and general manager, the Van Sicklen Co., 14 Chicago St., *Elgin, Ill.*

WALKER, HIRAM L. (M) assistant chief engineer, Chandler Motor Car Co., *Cleveland,* (mail) 13612 Rugby Road.

WHITE, GUY A. (J) resident engineer's office on special heat treatment work, Curtiss Aeroplane & Motor Corp., *Hammondsport, N. Y.*

WHITE, THOMAS H. (J) lieutenant, officer in charge of land and water transportation, Aeronautical Experimental Station, Langley Field, *Hampton, Va.*

WIGGINS, E. R. (M) technical editor, *Chilton Tractor Journal,* The Chilton Co., Philadelphia, (mail) Statler Hotel, *Detroit.*

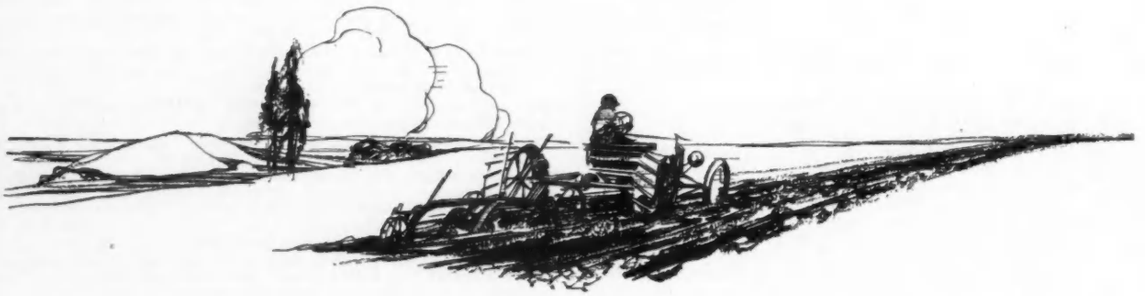
WILLIAMS, ALFRED O. (M) manager and mechanical engineer, South Bend Gear Co., *South Bend, Ind.*

WOLF, E. P. (A) vice-president and treasurer, Perfex Radiator Co., *Racine, Wis.*

WOTTON, EDWARD (A) superintendent of equipment, Fifth Avenue Coach Co., 10 East 102nd St., *New York City.*

ZEIGLER, L. A. (A) manager, the Zeigler Mfg. Co., *Alexandria, Ind.*

ZEITLER, RAYMOND S. (M) Engineering Section, Motor Transport Division, Q. M. C., Washington, president and chief engineer, Zeitler Gas Car & Locomotive Co., Chicago, (mail) 358 Union Station, care of Major Kalb, *Washington.*



Book Reviews *for* S. A. E. Members

This section of THE JOURNAL contains notices of the technical books considered to be of interest to members of the Society. Such books will be described as soon as possible after their receipt, the purpose being to show the general nature of their contents and to give an estimate of their value.

LIFE IN A TANK. By Richard Haigh, M.C. Published by Houghton, Mifflin Co., Cambridge, Mass. Cloth, 5 by 7¼ in., 141 pages, ill. Price $1.25 net.

A frank, manly, free-from-pose book on a still unfamiliar subject. It supplements pleasantly the address printed in this issue of THE JOURNAL by Lieut. E. H. Kinder of the Tank Corps, N. A., and is filled with details of the mechanism, how the tank works, how it feels to be riding in it, how and where it goes.

"It has been found in actual practice that despite the most careful observation and equally careful study of aeroplane photographs, there are, as a rule, just one or two machine guns which, either through bad luck or through precautions on the part of the enemy, have escaped destruction. These are the guns which inflict damage when the infantrymen go over and which may hold up an attack. The tank has been devised to cross shell craters, wire and trenches, be impervious to bullets and contain a certain number of guns to be used for knocking out such machine guns as are still in use, as well as to lay low the enemy infantry."

"When you enter a tank you go in head first, by the side doors. There is an emergency exit—a hole in the roof, which is used by the wise ones. You wiggle your body in with more or less grace, and then you stand up. If it is the first time, you are usually profane, for you have banged your head most unmercifully against the steel roof, and you learn, once and for all, that it is impossible to stand upright in a tank. Each one of us received our baptism in this way. Seven of us, crouched in uncomfortable positions, ruefully rubbed our heads, to Rigden's intense enjoyment. Our life in a tank had begun.

"We looked around the little chamber with eager curiosity. Our first thought was that seven men and an officer could never do any work in such a small place. Eight of us were jammed in but we were standing still. When it came to going into action and moving around inside the tank, it surely would be impossible—there was no room to pass one another. So we thought. In front were two stiff seats, one for the officer and one for the driver. Two narrow slits served as portholes through which to look ahead. In front of the officer was a map board and gun mounting; behind the engine, one on each side, were the secondary gears. Down the middle of the tank was the powerful engine, part of it covered with a hood, and along either side a narrow passage through which a man could slide from the officer's and driver's seat back and forth to the mechanism in the rear. There were four gun turrets, two on each side. There was also a place for a gun in the rear, but this was to be used rarely, for "Willies" do not often turn tail and flee!

"Along the steel walls were numberless ingenious little cupboards for stores, and ammunition cases were stacked high. Every bit of space was utilized. Electric bulbs lighted the interior. Beside the driver were the engine levers; behind the engine, the secondary gears, by which the machine is turned in any direction. All action inside is directed by signals, for when the tank moves the noise is such as to drown a man's voice.

"All that first day and for many days after we struggled with the intricacies of the mechanism."

* * * * * * * * * * *

"We awoke on a Monday morning with a delightful feeling that something pleasant was going to happen, for all the world the same sensation we used to experience in waking on our birthdays and suddenly remembering that gifts were sure to appear and that there would be something rather special for tea. By the time full consciousness returned, we remembered that this was the day when, for the first time, the tank was to be set in motion. Even the 'Old Bird' was eager.

"We hurry off to the tankdrome. One after another we slide in through the little door and are swallowed up. The door is bolted behind the last to enter. Officer and driver slip into their respective seats. The steel shutters of the portholes click as they are opened. The gunners take their positions. The driver opens the throttle a little and tickles the carbureter, and the engine is started up. The driver races the engine a moment, to warm her up. The officer reaches out a hand and signals for first speed on each gear; the driver throws his lever into first; he opens the throttle, the tank—our 'Willie' moves!

"Suppose you were locked in a steel box, with neither portholes to look through nor airholes to breathe from. Suppose you felt the steel box begin to move, and, of course, were unable to see where you were going. Can you imagine the sensation? Then you can guess the feelings of the men in a tank—excepting the officer and driver, who can see ahead through their portholes—when the monster gets under way. There are times, of course, with the bullets flying thick and fast, when all portholes for officer, driver, and gunners must be closed. Then we plunge ahead, taking an occasional glimpse through the special pin-point holes.

"Thirty ton of steel rolls along with its human freight. Suddenly the driver rings a bell. He presses another button, and signals the driver of the right-hand track into 'neutral.' This disconnects the track from the engine. The tank swings around to the right. The right-hand driver gets the signal 'first speed,' and we are off again, at a right angle to our former direction.

"Now we are headed for a gentle slope across the field, and as we approach it the tank digs her nose into the base of the hill. She crawls up. The men in the rear tip back and enjoy it hugely. If the hill is steep enough they may even find themselves lying flat on their backs or standing on their heads! But no such luck. Presently they are standing as nearly upright as it is ever possible to stand, and the tank is balancing on the top of the slope. The driver is not expert as yet, and we go over with an awful jolt and tumble forward. This is rare fun, but the instructor is not pleased. We must try it all over again, so back again to attack the hill a second time. The top is reached once more and we balance there. The driver throws out his clutch, we slip over very gently, and carefully he lets the clutch in again and down we go.

The 'Willie' flounders around for the fraction of a second, then, nothing daunted, she starts off once more. We have visions of her sweeping all before her some day far behind the German lines.

"Three or four weeks of this sort of thing, and we are hardened to it."

In another chapter "that peculiar feeling in the stomach which danger alone can produce," and then what happened are described. Two tank battles are explained in some detail and then back to rest and discipline, to "water, comparative quiet, blankets"—to "saluting with the greatest accuracy and fierceness."

Throughout the book the personal element is used with much skill and humor. While horrors are omitted, the author describes a near-by tank on fire in action and the passing of two comrades—pathetic tales, told with reserve.

The last chapter, on the philosophy of war, is a choice and calm bit of writing, containing both comfort and uplift for those who are to see nothing of the real thing and to do little more than wait for the end of the strife.

MICROSCOPIC EXAMINATION OF STEEL. By Henry Fay. Published by John Wiley & Sons, Inc., New York City. Cloth, 6 by 9 in., 18 pages of text, 1 diagram and 55 photographic reproductions of test specimens. Price $1.25.

The material contained in this small volume was originally issued by the Ordnance Department of the U. S. Army and represents the result of investigations carried on at the Watertown Arsenal. It was originally intended for the exclusive use of inspectors of ordnance material, but was brought out in its present form in response to the demand from others interested in the inspection of steel.

The book gives merely an outline of metallographic methods, illustrating typical examples. As the author states, it should be used with caution, inasmuch as metallographic diagnosis can be made only after much experience in the handling of a variety of materials.

After introductory remarks the author discusses the subject of slowly cooled steels, rapidly cooled steels, and annealed steels, showing by a number of photographic reproductions the effect of rapidity of cooling on the structure of the metal.

Various non-metallic impurities are next taken up under the heading of macrostructure (the appearance of the etched surface seen by the naked eye in contradistinction to microstructure, the appearance of the etched surface under a microscope) slag, streaks, heat-treatment and composition. Under the heading "Effect of Work on Grain Size," the author refers to specimens taken from a 10-in. rifle, a 14-in. gun lever, and a 12-in. naval gun, and illustrates defects in these parts photographically. Sections are devoted to the very practical subjects of polishing test specimens and etching their surfaces.

In conclusion the author writes: "It may be stated that there is a tendency to overrate the application of metallography. Used in connection with the physical tests and chemical analysis it furnishes valuable supplementary data.

"It will be found that by the examination of specimens whose heat-treatment is definitely known, the inspector will soon acquire a fund of valuable information which will enable him to diagnose an unknown steel correctly. Defective metal should be examined and its characteristics noted whenever and wherever it is found."

The fifty-five photographs showing the various test specimens are excellently reproduced on heavily coated paper and in themselves should be of the greatest value to those interested in the microscopic examination of steel.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, THIRD ANNUAL REPORT, 1917. Published by the Government Printing Office, 1918, at Washington. Paper, 7 by 10 in. 495 pages. Illustrated.

In addition to the usual review of activities, this report of the National Advisory Committee contains eleven technical reports. An outline of these reports follows:

Report No. 13, entitled "Meteorology and Aeronautics," was prepared by Prof. William R. Blair, in charge of aerological investigations, United States Weather Bureau, and submitted through the sub-committee on the relation of the atmosphere to aeronautics. This report discusses problems and general phenomena of the atmosphere. On request of the Signal Corps., it has been printed as a separate document by the committee for widespread distribution, as it contains information of special value to all aviators and aeronauts.

Report No. 14, entitled "Experimental Research on Air Propellers," was prepared and submitted by Dr. William F. Durand, chairman of the National Advisory Committee for Aeronautics. It has been printed by the committee as a separate document for immediate distribution in order to supply much-needed information at the earliest moment to those who are interested in the design of air propellers.

Report No. 15, entitled "Nomenclature for Aeronautics," was prepared and submitted by the sub-committee on nomenclature for aeronautics, of which Dr. Joseph S. Ames is chairman. It has been printed by the committee as a separate pamphlet.

Report No. 16, entitled "The Stretching of the Fabric and Deformation of the Hull in Full Balloons," is a translation from the German by Prof. Karl K. Darrow of the University of Chicago.

Report No. 17, entitled "An Investigation of the Elements Which Contribute to Statical and Dynamical Stability and of the Effect of Variation in Those Elements," was prepared by Prof. Alexander Klemin of the Massachusetts Institute of Technology, under contract entered into by the committee with Prof. C. H. Peabody of the same institution.

Report No. 18, entitled "Aerofoils and Aerofoil Structural Combinations," is a graduation thesis prepared at the Massachusetts Institute of Technology by Maj. H. S. Martin and Maj. E. S. Gorrell, and has been included in the present report by the committee because of the importance of the information which it contains.

Report No. 19, entitled "Periodic Stresses in Gyroscopic Bodies with Applications to Air Screws," was prepared and submitted under direction of Dr. A. F. Zahm of the Washington Navy Yard.

Report No. 20, entitled "Aerodynamic Coefficients and Transformation Tables," was prepared by the committee under direction of Dr. Joseph S. Ames.

Report No. 21, entitled "Theory of an Airplane Encountering Gusts, II," was presented as a paper before the American Philosophical Society by Prof. E. B. Wilson of the Massachusetts Institute of Technology, being a continuation of a report on the same subject printed in the first annual report of the committee.

Report No. 22, entitled "Fabrics for Aeronautic Construction," was prepared by E. D. Walen of the United States Bureau of Standards, and relates to standardization of materials. This report consists of two parts, the

(Continued on page 48, Advertising Section)